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THE RELATION OF THE SEXES TO GOVERNMENT.

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AS is well known, the diversity of sex is of very ancient origin. It appeared in the history of life before the rise of any but the most rudimental mentality, and has at various points in the line of development of living things displayed itself in the most pronounced manner. Great peculiarities of sex structure are witnessed in the higher forms of life, as in birds and mammalia. The greatest peculiarity of mental sex character can only be seen where mind is most developed—that is, in man.

From what we know of sexual as compared with non-sexual reproduction, the advent of the former marked an important advance in the possibilities of progress. Reproduction by gemmation in non-sexual forms, and parthenogenesis in sexual animals, have a different result from sexual reproduction. In the former the characters of the single parent are reproduced with great fidelity. The cultivator who wishes to keep his stock true, uses buds and cuttings. On the other hand, seedlings are variable; because the offspring of two sexes inherit twice as many elements of difference as those of a single sex. Another great gain was secured in the development of a male sex. Being free from the disabilities imposed by maternity, the male could acquire a greater mastery over his environment than the female. His time would be less occupied, and his opportunity for physical exertion greater, and he could and would take a more active part in the struggle for existence. Hence, of the two sexes the male became the fighter and the provider, and necessarily, from the increasing muscular strength acquired in this more active life, the master of the two. He, therefore, became more specialized in some respects, particularly in those necessary to success in his various

undertakings. His part in reproduction became a specialization as compared with that of the female, which more nearly resembles the asexual method. So the male became the author of variation in species in two ways: first, by adding to the sources of inheritance; and second, by his own more numerous specializations.

In man the mental organization of the sexes expresses these facts in various ways. The sexual mental characteristics of men and women have been described by Lecky, Delaunay, Ladd,* P. G. Hamerton, and others, and with a unanimity that would of itself be authoritative if they did not confirm the belief of thoughtful observers generally. Woman is not only restrained by her reproductive functions from taking the same active part in the world's life as does man; but, what is more important, she inherits a greater disability from thousands of ages of equal and in some cases greater disability in the countless generations of man's animal ancestors. This nature is thoroughly ingrained, and is as permanent as any other part of her organism. In considering these mental peculiarities, it must be borne in mind that she inherits from her father as well as from her mother, so that she has benefited by the general progress of the race, but her relation to the male remains the same in each family taken by itself. Thus it has resulted that the women of a higher race or family will display superior traits to men of a lower race or family, even in some of the endowments which are the especial field of the male. And it is comparisons of this sort which frequently cause the question to be raised, whether the supposed superior rationality with which men are credited is ascribed to them justly. In the great variety of history and origin possessed by the people who are thrown together by our modern civilization, it must often happen that the women of superior lineage provoke favorable comparison with men whose ancestors have emerged from semi-savagery within a comparatively recent period. Nevertheless, in these cases also, sex qualities of mind are well marked, though more or less limited on the part of the inferior type.

It is the fundamental fact above stated that needs to be considered before all others, by those persons who believe that the present relations of the sexes, socially and politically, can and should be improved. And the next fact to be considered is, that persons who do not undertake the special functions of sex are of secondary importance in the question. It is evident that the influence on future generations of persons who do not produce those generations is exceedingly small compared with the influence of the persons who do produce them; just in proportion as

* "Elements of Physiological Psychology," 1887.

acquired characters are in small proportion to inherited ones. In all influence that depends on physical conditions, that of parents immensely preponderates over that of all others. Hence, in the present paper the relations of parents will be considered rather than those of other persons. For the good of the race, the parent must have the first place in the mind of the legislator, and all other persons must occupy a position of subordinate importance.

In comparing male and female minds we should take them at their best and not at their worst. We should take real livers and not pretenders; that is, persons who exercise their higher faculties, or who live up to their capacities. Very many men and women waste their higher faculties by disuse, but the married are less apt to live this aimless life than the unmarried. As there are persons who deny matters of ordinary observation, the actual differences of the minds of the sexes in general may be very briefly enumerated. We find in man a greater *capacity* for rational processes, a capacity which is not always exercised to its full. We find in men a greater capacity for endurance of the activity of the rational faculty. We find in men a greater capacity for work in those departments of intelligence which require mechanical skill of a high order. In the æsthetic department, we find incapacity more general than in women, certainly in the department of the æsthetics of the person. In woman we find that the deficiency of endurance of the rational faculty is associated with a general incapacity for mental strain, and, as her emotional nature is stronger, that strain is more severe than it is in man under similar circumstances. Hence the easy breakdown under stress, which is probably the most distinctive feature of the female mind. This peculiarity, when pronounced, becomes the hysterical temperament. But in all departments of mental action that depend on affection or emotion for their excellence, woman is the superior of man; in those departments where affection should not enter, she is his inferior. I think that most of the peculiarities of mind of the sexes may be traced to these first principles. The origin of these leading differences is not difficult to trace to the different functions of the sexes in the family relation, emphasized by repetition throughout the long ages of vertebrate, mammalian, and human history. Beginning with the maternal instinct, woman has become, by constant exercise, a being of affections. Her long protection by the male has reduced her capacity for defense; while the mastery by him has accustomed her to yielding, and to the use of methods of accomplishing her desires other than force. There are apparent exceptions to these definitions, but they are generally more apparent than real. For one of the characteristics of the female of man, acquired by long practice, is a capacity for keeping up the appearance of possessing qualities in which she is

more or less deficient. A ready capacity for acquisition of knowledge, and skill in language, are important contributors to this result.

It would seem, then, that Nature has marked out very clearly the relative positions of the sexes of man. This relation is beneficial not only from a natural but also from a social standpoint. The sex affection or passion has the greatest influence in compelling evolution of unwilling lives, and of driving where nothing can lead. The best emotions are aroused in the man who finds a woman dependent on him for support, and the infant's breath will awake that woman to serious thought and exertion who never had a serious thought before. Nor is the mutual benefit confined to the earlier days of the relation. It has been said elsewhere:* "While the interests of the members of the same sex often bring them into collision with each other, those of opposite sex can not normally do so. While the contests of the members of the one sex are the active agent in evolution by rivalry and force, the relations of opposite sex furnish the inducement to progress offered by mutual admiration and pleasure. Among mankind the necessity of pleasing and of inspiring the respect of the opposite sex has a great deal to do with the becoming pleasant and respectable."

The functions of the sexes being, then, different in society, as in nature, the question arises, To what extent should they perform identical functions? This question is pressed upon us to-day, and demands have arisen that woman should compete with man in all the forms of human activity, and should even have a hand in the government, whether constitutional or monarchical. The object of the present essay is to enumerate a few practical points with reference to these questions.

So far as regards cultivation of the mind, there can be no doubt that women should have all the facilities that are open to men. As the mothers of the human race, they should be deprived of no opportunity for development. The education of girls should be pushed as far as is consistent with good health. Had the education of women been encouraged earlier in human history, the general intelligence of the species would have been at a higher point to-day.

The competition with men by women in the pursuit of a livelihood is a necessity wherever women so outnumber men that they can not all marry, and where polygamy is not practiced. It is compulsory, and questions of taste and feeling have to be put aside in considering it. And the same unbending necessity decides the pursuit in which woman fails and that in which she succeeds. In some she succeeds easily; in some she can never succeed.

* "The Forum," September, 1887, p. 53, "On the Object of Life."

Between these extremes lies a territory in which each case settles itself. But it will ever remain true that, for the normal woman, the home-life is both the easiest and the happiest.

When we come to the question of government, we reach a field in which the acts of men do not concern themselves alone, but exercise an important influence on the lives of others. Is woman by physical and mental constitution adapted to engage in the various duties and services required in the making and executing laws, and in the enterprises which nations find necessary in order to carry on their functions, and preserve themselves from internal and external enemies?

It must be here premised that the progress of civilization has thus far emphasized and not diminished the peculiarities of sex. The civilized woman is more refined, more tender, more intelligent, and more hysterical than her savage representative. Her form is more different from that of the male, and her face more expressive of her distinctive character. There is good reason to believe that this development has been due to the increased immunity from the severity of the "struggle for existence" which woman enjoys in civilized communities, and the greater opportunity thus given her to develop her own especial excellences.

The first thought that strikes us in considering the woman-suffrage movement is, that it is a proposition to engage women once more in that "struggle" from which civilization has enabled them in great measure to escape; and that its effect, if long continued and fairly tried, will be to check the development of woman as such, and to bring to bear on her influences of a kind different from those which have been hitherto active. And it becomes an impartial thinker to examine the question more closely, and see whether investigation bears out these impressions or not. We inquire, then, in the first place, is government a function adapted to the female character, or within the scope of her natural powers? We then endeavor to discover whether her occupation of this field of action is calculated to promote the mutual sex interest which has been referred to above, and thus to subserve the natural evolution of humanity.

In endeavoring to answer the first question we are at once met by the undoubted fact that woman is physically incapable of carrying into execution any law she may enact. She can not, therefore, be called on to serve in any executive capacity where law is to be executed on adults. Now, service in the support of laws enacted by those who "rule by the consent of the governed" is a *sine qua non* of the right to elect governors. It is a common necessity to which all of the male sex are, during most of their lives, liable to be called on to sustain. This consideration alone, it appears to me, puts the propriety of female suffrage out of the

question. The situation is such that the sexes can not take an equal share of governmental responsibilities even if they should desire to do so. Woman suffrage becomes government by women alone on every occasion where a measure is carried by the aid of woman's votes. If such a measure should be obnoxious to a majority of men, they could successfully defy a party composed of a minority of their own sex and a majority of women. That this would be done there can be no question, for we have a parallel case in the attempt to carry into effect negro suffrage in some parts of the South. We know the history too well. Intimidation, deception, and the manipulation of the count, have nullified the negro vote. How many Governors, Legislatures, and even Presidents have attained their positions in violation of the rights of the ballot during the last twenty years, we may never know. In times of peace and general prosperity these things have excited indignant protest, but nothing more. But when serious issues distract the nation or any part of it, frauds on the ballot and intimidation of voters will be a more serious matter, and will lead to disastrous consequences. We do not want to increase possibilities of such evil portent. Unqualified negro suffrage is, in the writer's estimation, a serious blunder, and woman suffrage would be another. And it is now proposed that we have both combined.

Immunity from service in executing the law would make most women irresponsible voters. But there are other reasons why the questions involved in government are foreign to the thoughts of most women. The characteristics of the female mind have been already described. Most men who have associated much with girls and women remember how many needed lessons they have learned from them in refinement and benevolence; and how they have had, on the other hand, to steel their minds against their aimlessness and pettiness. And from youth to later years they have observed one peculiarity for which no remedy has been yet found, and that is, a pronounced frailty of the rational faculty in thought or action. This characteristic is offset by a strength and elevation of the emotional nature, which shines with inextinguishable luster in the wife and mother. It is to this that man renders the homage of respect, admiration, and such devotion as he is capable of. But, are these the qualities for our governors? Men who display personal bias in ever so small a degree, unless accompanied by unusual merits of another kind, are not selected by their fellows for positions of responsibility and trust. Strong understanding, vigorous judgment, and the absence of "fear, favor, and affection," are what men desire in their governors; for only through minds of that character can justice be obtained.

On account of their stronger sympathies girls always think themselves the moral superiors of boys, who are often singularly

devoid of benevolence, especially toward the lower animals. Some women imagine, for this reason, that their entire sex is morally the superior of the male. But a good many women learn to correct this opinion. In departments of morals which depend on the emotional nature, women are the superior; for those which depend on the rational nature, man is the superior. When the balance is struck, I can see no inferiority on either side. But the quality of justice remains with the male. It is on this that men and women must alike depend, and hence it is that women so often prefer to be judged by men rather than by their own sex. They will not gain anything, I believe, by assuming the right of suffrage, that they can not gain without it, and they might meet with serious loss. In serving the principle of "the greatest good of the greatest number," man is constantly called on to disregard the feelings of particular persons, and even to outrage their dearest ties of home and family. Woman can not do this judicially. After the terrors of the law have done their work, woman steps in and binds up the wounds of the victims, and the world blesses both the avenger and the comforter.

In the practical working of woman suffrage, women would either vote in accordance with the views of their husbands and lovers or they would not. Should they do the former habitually, such suffrage becomes a farce, and the only result would be to increase the aggregate number of votes cast. Should women vote in opposition to the men to whom they are bound by ties sentimental or material, unpleasant consequences would sooner or later arise. No man would view with equanimity the spectacle of his wife or daughters nullifying his vote at the polls, or contributing their influence to sustain a policy of government which he should think injurious to his own well-being or that of the community. His purse would be more open to sustain the interests of his own political party, and if he lived in the country he would probably not furnish transportation to the polls for such members of his family as voted against him. He would not probably willingly entertain at his house persons who should be active in obtaining the votes of his wife and daughters against himself; and on the other hand the wife might refuse entertainment to the active agents of the party with which she might not be in sympathy. The unpleasantness in the social circle which comes into view with the advent of woman suffrage is formidable in the extreme, and nothing less than some necessity yet undreamed of should induce us to give entrance to such a disturber of the peace. We need no additional causes of marital infelicity. But we are told by the woman-suffrage advocate that such objections on the part of men are without good reason, and are prejudices which should be set aside. But they can not be set aside so long as human na-

ture remains what it is. Men may grant women anything but the right to rule them, but there they draw the line. Is it not on questions of rule that the wars of men are mostly fought, and will men yield to the weak what they only surrender to irresistible force? In the settlement of all questions by force, women are only in the way.

The effect of sexual discord is bad on both sexes, but has its greatest influence for evil through woman. While it does not remove her frailties it suppresses her distinctively feminine virtues. This suppression, continued for a few generations, must end in their greater or less abolition. The lower instincts would remain, the flowers which blossom on that stem would wither. No matter what their intellectuality might be, such women would produce a race of moral barbarians, which would perish ultimately through intestine strife. The highest interests and pleasures of the male man are bound up in the effective preservation of the domestic affections of his partner. Where these traits are weak, he should use every effort to develop them by giving them healthy exercise. As in all evolution, disuse ultimately ends in atrophy, and the atrophy of the affections in woman is a disaster in direct proportion to its extent. It may be replied again that woman suffrage carries with it no such probable result. But I believe that it does, unless the relations of the sexes are to be reversed. But it will be difficult to reduce the male man to the condition of the drone-bee (although some men seem willing to fill that *rôle*); or of the male spider, who is first a husband and then a meal for his spouse. We have gone too far in the opposite direction for that. It will be easier to produce a reversion to barbarism in both sexes by the loss of their mutual mental hyperæsthesia.

If women would gain anything with the suffrage that they can not gain without it, one argument would exist in its favor to the many against it; but the cause of women has made great progress without it, and will, I hope, continue to do so. Even in the matter of obtaining greater facilities for divorce from drunken or insane or brutal husbands than now exist in many States of the Union, they can compel progress by agitation. A woman's society, with this reform as its object, would obtain definite results. The supposition that woman would improve the price of her labor by legislation is not more reasonable than it is in the case of men, who have to yield to the inexorable law of supply and demand.

When we consider the losses that women would sustain with the suffrage carried into effect *bona fide*, the reasons in its favor dwindle out of sight. The first effect would be to render marriage more undesirable to women than it is now. A premium would be at once set on unmarried life for women, and the *hetæra* would become a more important person to herself and to

the state, than the wife, because more independent. The number of men and women who would adopt some system of marriage without obligation, would greatly increase. Confidence and sympathy between married people would be in many instances impaired; in fact, the first and many other steps would be taken in the process of weakening home affection, and there would follow a corresponding loss of its civilizing influences and a turning backward of the current of moral progress. The intervention of women into public affairs is to be dreaded also by those who desire peace among men. Both women and their male friends resent treatment for them which men would quite disregard as applied to themselves; and woman suffrage would see the introduction of more or less numerous women into public life. The extreme and irresponsible language used by Mrs. Stanton and Mrs. Lathrop at the last woman's congress in Washington effectively illustrate this aspect of the question.

The devotional nature of women must not be left out of the account in considering this question. While this element is of immense value to that sex and to society when expended upon ethical themes, when it is allied to theological issues it becomes an obstruction to progress of the most serious nature. Were woman suffrage granted, theological questions would at once assume a new political importance, and religious liberty and toleration would have to pass through new perils and endure the test of new strains. What the effect would be we can not foresee, but it could not be good. The priest would acquire a new political importance, and the availability of candidates would be greatly influenced by the question of their church affiliations.

Many objections would be nullified if women should vote under the immediate direction of their responsible male associates, except the one based on their exemption from the execution of the laws; but, should they so vote, woman suffrage becomes a farce, as it is to that extent where it now prevails. The very essential support given by women voters to polygamy in Utah is an illustration of this. In Wyoming men load up wagons with their women to drive them to the polls to *vote their own ticket*, as I have had the opportunity of seeing in that Territory; and so they would do everywhere. If they wished to vote otherwise, they might stay at home; and it is to be expected that women would sometimes wish to vote "otherwise."

What I have written does not include any reference to supposed inherent right to the suffrage or to any principles of representative government. This is because the view that suffrage is not a right but a privilege appears to the writer to be the most rational one, and because any system of government which tends to disturb the natural relations of the sexes I believe to be most

injurious. In the absolute governments of Europe the home is safe whatever else may suffer; but a system which shall tend to the dissolution of the home is more dangerous than any form of absolutism which at the same time respects the social unit.

What America needs is not an extension, but a restriction of the suffrage.

A LIVING MYSTERY.

By GRANT ALLEN.

I HOLD in my hand here a key to one of the greatest mysteries of life—the perennial mystery of birth and reproduction.

And yet you needn't be in the least afraid that the mystery or its solution involves any technical scientific language, or possesses any tinge of occult abstruseness. It is only a pea that I hold here before me, an ordinary small, round, yellow marrowfat, the seed of the commonest of garden annuals. Nevertheless, that familiar little object, which all of us have known all the days of our life, incloses in itself the entire solution of the riddle of birth. If we understand the pea clearly, we understand the whole science of biology. Let us ask ourselves first, exactly what it is, and then see how it helps us to comprehend the coming into existence of all the higher plants and animals.

The pea is, in fact, here as it stands, a whole embryo plant in a dormant condition, the product, so to speak, of a distinct marriage. More than that, it is a totally new individual, produced by the interaction of separate cells from two pre-existing individual pea-plants. And it is that fact—which it owns in common with every other seed—that gives it illustrative importance as an example of the mode of production of all higher organisms, animal or vegetable. We may use it to explain this fundamental mystery of advanced life, because the principles which govern its origin and growth are the same as the principles which govern the beginning of all other conspicuous plants or animals in the world around us.

If you bend down a branch of a rose-tree, and cover it with earth, it will take root—make a layer, as we say, and grow up apparently into a separate rose-bush. After it has rooted itself firmly in the damp soil, you can cut it off with safety from the mother-plant, and remove it or transplant it to another part of the garden, where it will form, to all outward show, a distinct individual. Similarly, if you take cuttings from a scarlet geranium, and plant them in pots, you can multiply your original specimens in different places to almost any desired extent. In many cases, Nature has even provided beforehand, as it were, for such purely

vegetative propagation of a particular species. In the tiger-lily, for example, the tiny bulbels, that spring from the axil of every leaf, fall off when mature, and form distinct or separate plants on the ground beneath. In other instances, suckers, offshoots, or scions are produced, sometimes underground, as in the Jerusalem artichoke, sometimes above, as in the potentillas and hawkweeds, all of which grow out, to all appearance, into plants like the one from which they originally separated themselves. Many plants produce long, creeping branches, which regularly and systematically root at the nodes. The runners of strawberries are a familiar example of this mode of growth; so, in a somewhat different way, are the eyes of potatoes, the small side-bulbs in certain forms of onion, and the long, underground suckers or scions of the twitch or couch-grass.

When we come to look a little closer, however, at the nature of such seeming reproduction, we can see at once that in none of these cases is a new individual—in the truest sense of the word—really produced: all that has been done is to split up the original single organism into a number of colonies, as it were, or component parts, all still retaining the primitive individuality in shape, color, and every other particular. The branch is a branch while it remains on the tree; it is still none the less a branch in all essentials after it has been severed as a cutting, and made to root afresh like a distinct plant, apart from the remainder of the primitive individual to which it belongs.* Gardeners and agriculturists are perfectly aware of the truth of this principle, at least as regards its practical aspect, for they take advantage of it freely in the case of varieties which, as they say, "will not come true from seed." A particular potato-plant, let us say, or a particular rose-tree, possesses certain individual points, which render it desirable in cultivation; and, instead of seeding it, by crossing with another individual, and taking their chance among the seedlings (in which the special peculiarities seldom reappear), gardeners prefer to divide and multiply the original individual to the utmost possible extent, so as to make sure of retaining all the strong points of the plant in question, undiluted by crossing. All the Marshal Niels in existence, for example, are, in the last resort, cuttings from a particular, individual French rose-bush; all the British-Queen strawberry-plants are offsets by runners from a single, exceptionally fine-fruiting seedling.

Take an instance which I see before my eyes this very moment as I raise my head from my temporary study-table on a North African hill-side. The date-palms, which form the wealth of the

* I do not mean herein to dissent from Mr. Herbert Spencer's views as to what constitutes an individual. The apparent discrepancy, rendered necessary by the conditions of popular explanation, will be fully got rid of a little further on.

Arabs of the desert, and one of which now waves its long boughs in the breeze before us, are all female; the male or pollen-bearing flowers of the date kind always grow on a separate tree; and as pollen is produced by them in vast quantities, it is not necessary in palm-groves to have more than a single male stem to some forty or fifty fruit-bearing individuals. The Arabs, therefore, never raise their palms from seed, as they can not make sure of the sex of seedlings; they take suckers from the root of a female tree, already known to be a good bearer of fine fruit; and these suckers not only follow the sex of the so-called mother, but also reproduce its special peculiarities of flower and seed in every respect. They can not fail to do so, indeed, seeing that they are part and parcel of the original palm, actual members of the self-same plant; just as the various branches of an apple-tree all bear the same kind of apples, or the boughs of a currant-bush all produce the self-same currants.

And now let us hark back, by way of contrast, to the case of the pea, which is a true, distinct, individual plant, the product of a veritable marriage union. Whence came it? Was it born from a pea-blossom? So, indeed, we mostly imagine; though very incorrectly. As well say that a child is the son of his mother, but not of his father, as that a pea is the seed produced by a pea-flower. It is nothing of the sort. The whole secret of sex and reproduction is bound up in this simple illustrative instance. The pea is the product of *two different pea-blossoms.*

The mere accidental fact that each pea-blossom had stamens and pistil in its own flower must not blind us to the truth of this underlying principle of cross-fertilization, which every pea exemplifies for us as truly as every date or every melon. In the date and the melon the flowers on one plant are all male or all female; on the pea-vine they are all hermaphrodite. But, none the less, they intermarry. What happened when the pea was first launched into life was briefly this: A row of peas grew in the garden of the Moorish villa that gleams in the sun on the hill-side opposite; and on one of these vines hung a particular white-winged blossom, which supplied the pollen for the production of this individual pea. On another vine hung a second flower, from whose midst protruded the pistil which was finally to grow out into the particular pod that contained my pea. A wandering bumble-bee, on dinner intent, poked his long proboscis into pea-flower number one, and, after rifling it of its honey, covered his hairy legs and thighs, half accidentally, with abundant pollen from the stamens, which formed a sheath or tube round its twisted style. Then he flew away to pea-flower number two, and, in his clumsy attempts to thrust his long sucker down its nectar-bearing throat, he brushed a lot of number one's pollen from his legs and breast on

to the ripe stigma or sensitive surface of number two's undeveloped pod. So much alone we can see for ourselves with the unaided eye of outer observation. How much more of the history of this matter will dissection and the microscope finally tell us?

Inside the keel or lower petal of the pea the young pod pushes out its style and brush-like stigma to meet the advances of the fertilizing bee. On the end of the style, at the inner surface, a group of delicate hairs protrudes from the stigma; and it is on these hairs that the bee casually and almost accidentally (so far as he is concerned) deposits the pollen-grains he has carried off from the brother-blossom. Forthwith, each pollen-grain, meeting with the sensitive surface of a sister-style, and recognizing its position, begins to emit a tube of highly vital matter, which bursts out from its side and seeks a vent to penetrate the pod in the exact center of the neighboring flower. Now the hairs, on whose tip the pollen-grain has been deposited, are tubular and hollow; and the pollen-tubes, running down the style along these pre-established routes, soon reach the little ovules, or undeveloped peas, that lie concealed in the pod within. There it is that the actual, intimate work of fertilization itself really takes place. The vital material of plant number one, laid by in the pollen, enters and mixes with the vital material of plant number two, laid by in the ovule; and from their intermixture and union, in the most physical sense, there springs at last the wonderful little object I see before me—the pea itself, a dormant plantlet, waiting only for heat and moisture to wake it into life, that it may grow into a new and separate individual pea-vine.

Now, note the importance of this act of fertilization. Unless the pollen had reached the ovules in the undeveloped pod, the tiny peas therein contained would never have swollen or developed into perfect seeds at all. The flower in that case would have withered on its stalk, and the pod would have dried up to an abortive and shriveled mass of empty membrane. It was the union of the pollen of one plant with the ovules of another that produced this entirely new individual, a compound and outgrowth, not of one but of two distinct pre-existing organisms. The vital material inside the bee is the vital material of the one, re-enforced and vivified by the diverse vital material of the other.

In order to understand the use and object of this peculiar provision of Nature, whereby every higher plant or animal is the product of two prior individuals whom we call its parents, we must look first more closely at the phenomena of ordinary vegetative growth, and thus see wherein this higher mode of reproduction differs essentially from that simpler and lower function.

All plants (roughly speaking) can produce from certain parts of themselves new leaves and branches; and each such leaf, from

the extreme theoretical and biological point of view, must be regarded to some extent as a distinct individual. Nevertheless, the entire colony of leaves, the herb, shrub, or tree, as we generally call it, has also a sort of complex individuality of its own; it is an organism in itself, containing various parts or members, such as roots, stems, leaves, and so forth, each performing distinct functions for the good of the entire complex body. Now, the plant goes on for a certain length of time producing leaves from its surplus material one after another; and, as long as fresh material is supplied, this production or growth seems in some cases to have hardly any distinct limit. Strawberries, for example, will go on sending out runners (which are merely branches with tufts of leaves at the end that root from time to time) almost endlessly. We have here an example of continuous non-sexual reproduction. There are in nature innumerable variations in the manner of such purely vegetative growth. Sometimes, as in deciduous trees, the leaves all fall off in autumn, and totally new ones are brought forth from buds in the succeeding season; sometimes, as in the potato, new shoots spring from swollen underground branches; sometimes, as in the crocus, small bulbs are developed as stocks on the top of the old one. But, whatever the variation, the central fact still remains the same: the leaves, stems, or branches thus put forth are, strictly speaking, parts of the same compound organism, asexually produced, not entirely new and separate individuals.

A plant, however, no matter how vivacious, can hardly go on living forever. Sooner or later, there is reason to believe, this purely vegetative growth fails. The original vigor of its constitution gets used up; the life and go of the plant become hopelessly weakened. This seems to be the case at the present day, for instance, with the cultivated potato, which has been propagated from the tubers almost exclusively for many years, so that the existing plants must be of immense age, and have grown effete and feeble for want of proper sexual renewal. How are plants which have thus reached their dotage to restore their youth? How are they to carry on to future years the life of the species?

Nature has answered this problem of life by the wonderful device of intercrossing. The organism, like every other machine, tends in time to wear out and decay. But, unlike other machines, it contains in itself (through the action of natural selection) the means for manufacturing its own successors.

The leaf, we saw, grows out from the leaf. If you cut a piece of the common cactus or prickly-pear, and drop it on the ground, it roots at once and grows up afresh into a full-grown cactus-plant. There are some leaves which, if hung up, produce other leaves and little plants from their edges; and everybody must

have noticed how the common stone-crops will grow and root from any little scrap or fragment or bit that falls by accident upon damp soil. If we go down to the very bottom of the matter, it is clear that the plant tends to reproduce itself, whole and complete, from every part of itself—tends to increase in its own shape, and repeat itself anew in fresh leaves and branches. Why is this? Well, such a tendency results necessarily from the fundamental principle of cell-growth. Every living vegetable cell containing chlorophyl is always producing within itself fresh vital matter of its own kind; and this vital matter, at last outgrowing the capacity of the mother-cell, pushes itself out through the cell-wall, and grows into a new cell like the one it left. And it does so in the very last resort in virtue of that curious chemical property of the stuff we call chlorophyl, whereby such chlorophyl, under the influence of sunlight, separates the carbon and oxygen of carbonic acid, and builds them up once more into living matter of the particular sort composing the plant in which it exists.

Given a chemical body which can so increase the sum-total of living matter, and there must needs result the phenomenon of growth. Living matter is always being made anew from the non-living. But observe that in each plant the material thus assimilated from the air (or rather the carbonic acid floating in it), and more remotely from the earth and water, is built up into the forms of the particular plant itself—becomes distinctively, not mere living matter in the abstract, but strawberry matter, or stone-crop matter, or cactus matter, or whatever else the individual plant may happen to be. In this we get the real secret of like reproducing like. It results as a corollary from the principle of assimilation. Most people see a mystery in the particular fact that offspring resemble parents, but they see no mystery in the general fact that the parent reproduces or renews the parts of itself from alien material. In reality, the final explanation lies on this deeper and more essential level. It is just as strange that a rose should put out fresh leaves and shoots as that its seed should grow up into a fresh rose-bush.

The true explanation seems to be, as Mr. Herbert Spencer long ago suggested, that each organism has an inherent physical tendency (of the nature of polarity) to complete its own organic form, in somewhat the same way as a broken crystal, placed in a solution of its own material, has a tendency to replace its lost portions. The organic type, in other words, resembles the crystalline in this—that the material of which it is composed, when left to its own internal forces, tends, under the free play of those forces alone, to arrange itself in a certain definite specific shape.

In time, however, every organism or colony of organisms seems to lose this primitive plastic power of producing fresh

parts out of its own material. Old age, as we say, comes on. And this is specially true of the higher and more complex organisms. The tree no longer puts forth new leaves; the plant no longer sends out fresh branches. Its individual vigor appears to be used up. Unless, then, some fresh stimulus can be supplied it from without, the plant must die, and the species thus must suffer extinction.

At this point, therefore, Nature steps in with a special remedy —the special remedy of cross-fertilization. The earliest and simplest form of this device is seen in certain algæ or pond-weeds, mere long green hairs that wave about like tresses in the water, and consist each of endless rows of cells growing out in single file like the beads of a necklace one from the other. But every now and then two of these algæ "conjugate," as biologists put it—that is to say, a cell of one bends over and unites with a cell of the other, the cell-contents (or protoplasm and chlorophyl) of one cell breaking through to join the cell-contents of its neighbor. The union thus effected seems to supply a fresh stimulus to growth: the two matters coalesce and combine, and a new and more vigorous alga springs up as the final result of this combination.

Now, in the higher plants we get exactly the same sort of combination, only far more complex in its mechanism and results. If we take any annual plant, like the pea, and look when and where the flowers are produced, we shall see that they come as soon as the plant has attained its full growth, and when the purely vegetative reproductive impulse is beginning to fail. As a rule, too, the flowers come at the end of the branches, and in many—indeed, in most—plants they form a terminal spike or bunch at the summit of the stem, as in the familiar instances of the hyacinth, the buttercup, the sunflower, or the grasses. In other words, as soon as the vegetative growth is beginning to slacken, the need is felt for "fresh blood," for the special stimulus or fillip to further exertion given by union with another individual.

For the purpose of bringing about the desired union, all the higher plants are supplied with special organs known as stamens and pistils. The pistils produce the embryo seed, which is, in fact, a tiny separate plant, whose development is arrested at a very early stage, *unless fresh material from a neighboring stamen is supplied to supplement it.* The stamens produce the pollen-grains, which are, in fact, free cells containing a large quantity of very vitalized matter capable of fertilizing and vivifying the embryo seed. When a grain of pollen is placed by any agency whatsoever —wind, an insect, or a camel's-hair brush, as the case may be—on a neighboring stigma, it sends out a pollen-tube which penetrates the ovary and at last enters into and coalesces with the embryo seed itself. The fresh material thus added to the embryo seems

to upset the dormant condition—allows the failing growth to continue. The seed swells, the fruit ripens, and a new plant is shed forth upon the earth, the product of two distinct prior individuals.

But if the embryo is not thus quickened, growth in it ceases altogether. The seed shrivels up, the pod does not swell, and no new plant is produced at all. It does not contain within itself the needful energy for further development. Supposing all the flowers on a pea-plant were thus to fail—supposing no pollen were ever to be carried from blossom to blossom—then that particular plant would wither and die out altogether, leaving no offspring at all behind to represent it.

In the case we have supposed, however, the flower *did* get fertilized, and the pea before me—a dormant but still a living plant—is the irrefragable proof that it actually did so. Now, in some instances, perhaps in this one, a flower gets fertilized with its own pollen. In such cases, as a rule, the fruit nevertheless swells out properly and the seed produces a young plant. How, then, are we to reconcile this apparent discrepancy with the general principles of sexual growth laid down above? Well, we must recollect that in a certain sense each leaf is a distinct individual. Again, from the biological point of view the flower consists of modified leaves, some of them specialized to do duty as sepals, some as petals, some as stamens, and some as ovaries. Each of these is therefore in some sense an individual. In the entire community or compound organism, in other words, we may regard the stamens and ovaries as particular members, told off, like the queen-bees and drones in the hive, to fulfill the part of fathers and mothers, while the true leaves, like the workers, provide the food or material for growth. Thus, even in the same flower the stamens and ovaries are properly to be regarded as distinct individuals, capable of producing healthy offspring with one another, like the queen-bees and drones of the same hive.

Nature, however, does not stop here. The fundamental fact at the bottom of all fertilization whatsoever seems to be this, that where individual formative power fails it can be supplemented and set on foot again by an access of fresh formative power from without. Union is strength: what one can not do, two can. But the fresh fillip seems to be most distinctly felt when it comes not from another member of the same original colony—that is to say, from a stamen of the same blossom or of another blossom on the same plant—but from a totally distinct and separate colony, or, in other words and in more familiar language, from the flower on another neighboring plant. Where the parents are too closely related, it would seem, both are apt to have the same weak points, which therefore reappear in the offspring and vitiate it. But

deeper down even than that, since both belong to the same colony at the same period of failing growth, the impulse to fresh effort afforded by such a union would appear to be less; indeed, in some cases it is quite inoperative; whereas, when each comes from a separate plant, not only are the chances of diversity in constitution greater, but the constitutional fillip or stimulus to growth is more distinctly marked. Birth is a result of the union of unlikenesses.

Hence, while among the lowest and least developed flowers self-fertilization (or, to speak more correctly, fertilization of each ovary by its brother-stamens) is very common, among the higher and more specially adapted plants devices for promoting cross-fertilization, either by wind or insects, are almost universal. In some instances, indeed, the ovary can not be impregnated by pollen coming from the same flower—the fillip does not seem sufficient to promote growth, and the ovary touched only with pollen of a neighboring stamen remains to the end perfectly sterile. Truly distinct pollen is needed to quicken it. In other cases, though such incapacity does not exist, special arrangements have been made to prevent self-fertilization—the stamens and pistils do not mature together, or else they are so arranged in the blossom that contact of the pollen with the stigma is almost impossible. And in some of the very highest plants of all, the stamen-bearing and ovary-bearing flowers are distributed on totally distinct trees or bushes, thus affording the most perfect known development of the sexual principle—a sort of automatic compulsory exogamy, whereby each blossom must needs intermarry with a member of an entirely different colony.

For the same reason it will now, I hope, at once be clear why the offspring in every case resembles on the whole both parents equally. The various leaves which each rose-tree puts forth are exactly alike, and we don't expect them to be at all otherwise, because they are all similar products of the self-same active and formative energy. However much we may subdivide the parts of a plant, we look forward to finding its manifestations remain unchanged, as in the familiar case of cuttings, grafts, layers, suckers, bulbs, and runners. The different leaves, made of the same ultimate stuff, the new material of the species, resemble one another exactly as two parts of the same lump of clay or putty have similar characters; or exactly as the two halves of the same crystal rebuild their lost parts and renew their original shape alike when immersed in a mass of the same mother-liquid. So, too, we may well believe the undeveloped embryo or unfertilized seed potentially resembles in all things (as far as it goes) the mother-plant; but, as soon as it is fertilized by the pollen from its neighbor, it becomes in every portion of itself part and parcel of two previous

plants; or rather, the resulting new organism is the outcome of a compromise, perhaps even of a struggle for mastery, between all the parts or component elements of the two parent plants. Hence, in all species, animal or vegetable alike, the young on the whole tend to resemble both parents equally, but in different modes of combination, which give them each what we call individuality, and so make them really and truly new plants, not mere reissues of either parent form.

When I had written thus far on this present article, I laid down my pen for a little rest, and strolled out alone upon the dry African hill-side, a lower shoulder of the Atlas range, that stands opposite the villa whence I date these words. By a curious coincidence, as I rambled through the lentisk scrub, I happened to light upon a little bed of natural hybrid orchids, which so admirably illustrate the nature of this peculiar intermixture that I joyfully accepted them to point the moral with which I must close this long lay sermon. Numbers of a large and handsome yellow orchid grow on the slopes of that particular hill, and in and out among them spring members of another yet closely related species, dingier brown, and different in shape, disposition of parts, and general appearance. Some wandering bee, visiting a flower of the yellow orchid at this spot where I stood, had carried away on his head its gummy pollen-masses, and then, contrary to the common habit of bees (who generally visit only one particular species of plant at a time), had deposited them on the stigma of a neighboring brown specimen. I suppose he was a young and inexperienced insect, who had not yet learned to avoid the bad practice of mixing his honeys. From this chance fertilization any number of hybrids had taken their rise, all of them more or less resembling in certain respects both parents. In most cases they had, to a great extent, the distinctive shapes of the brown kind, with a preponderating amount of yellow color. But among them all they presented every possible intermediate type between the two parent forms. It seemed to me that this accidental find exactly fitted in with the subject of my paper. We see here how each embryo seed, separately impregnated by a pollen-grain from another plant, grows out with a tendency to reproduce both ancestral forms equally, and how the conflict between the two tendencies, both of which can not fully be realized, produces in the end an individual compromise—a something which is not quite either, but which combines in varying and incalculable degrees the strongest points of both.

Unless I mistake, we have here the solution (suggested in the main by Mr. Herbert Spencer) for one of the deepest and most fundamental problems of all life, animal or vegetable—the problem of reproduction, heredity, and individual variation.

THE GROWTH OF JELLY-FISHES.

A CHAPTER IN THE NEW ZOÖLOGY.

By Prof. W. K. BROOKS,
of Johns Hopkins University.

II.

[*Concluded.*]

IN the first part of this article I described the life-histories of two hydroids: one, Liriope, in which each egg gives rise to only one jelly-fish, which is solitary and free at all stages of its existence, and without any power to multiply asexually; and a second species, Dysmorphosa, in which there is no limit to the number of adults to which a single egg may give rise, and in which the life-history is a complicated alternation of generations, with a sessile polymorphic hydroid stage from which the sexual jelly-fishes are produced by budding.

I shall now briefly sketch the more prominent features in the history of the process of specialization which has gradually evolved a complicated life-cycle like that of Dysmorphosa from one as simple and direct as that of Liriope. The parasitic jelly-fishes are peculiarly instructive in this connection. The genus *Cunina* includes a number of species which, while young, are parasites on other jelly-fishes. The free-swimming adult of one of them (*Cunocantha octonaria*) is shown in Fig. 9. It is quite

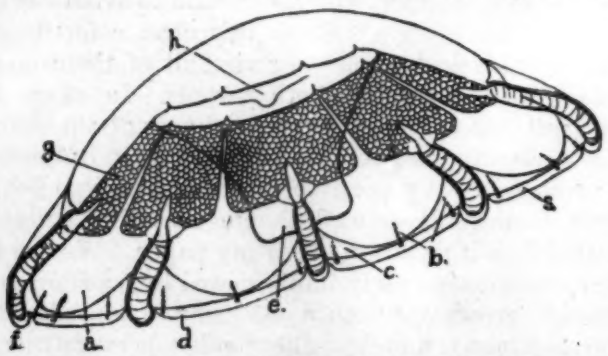

Fig. 9.—Side view of *Cunocantha octonaria*, slightly magnified, drawn from Nature by W. K. Brooks.

common upon the coast of Virginia and North and South Carolina. The adult is not a parasite, but as soon as the larvæ hatch from the eggs they make their way into the bell of another jelly-fish, and live there as parasites until they complete their development and assume the adult form. The jelly-fish which affords a home for these parasites is shown at K in Fig. 15. It is known as Turritopsis.

The hydra which hatches from the egg of the Cunina is free, like the hydra-larva of Liriope. It has a short globular body, and an enormously elongated proboscis, at the tip of which the mouth is situated (Fig. 10). It has four short tentacles which are turned backward away from the mouth, and are terminated by round knobs, which are used for clinging to the body of the Turritopsis, for as the parasitic larva sucks its food out of the stomach of its host, it does not need to use its tentacles for capturing living animals. As soon as it finds its way into the bell of a Turritopsis it fastens itself securely by its tentacles to its inner surface in the angle at the base of the stomach, where it is in no danger of being swept away by the current which the Turritopsis produces while swimming, and, once securely fastened, it bends down its long proboscis, passes it up through the mouth of the Turritopsis into its stomach, and sucks out the digested food.

Turritopsis is shown at K in Fig. 15; and Fig. 11, which I have copied from McCrady, the discoverer of this remarkable case of parasitism, shows the outline of the inner surface of the bell, and of the stomach of Turritopsis, with three of the parasitic Cunina larvæ in place, fastened by their tentacles, and with their mouths inserted into the stomach of their host.

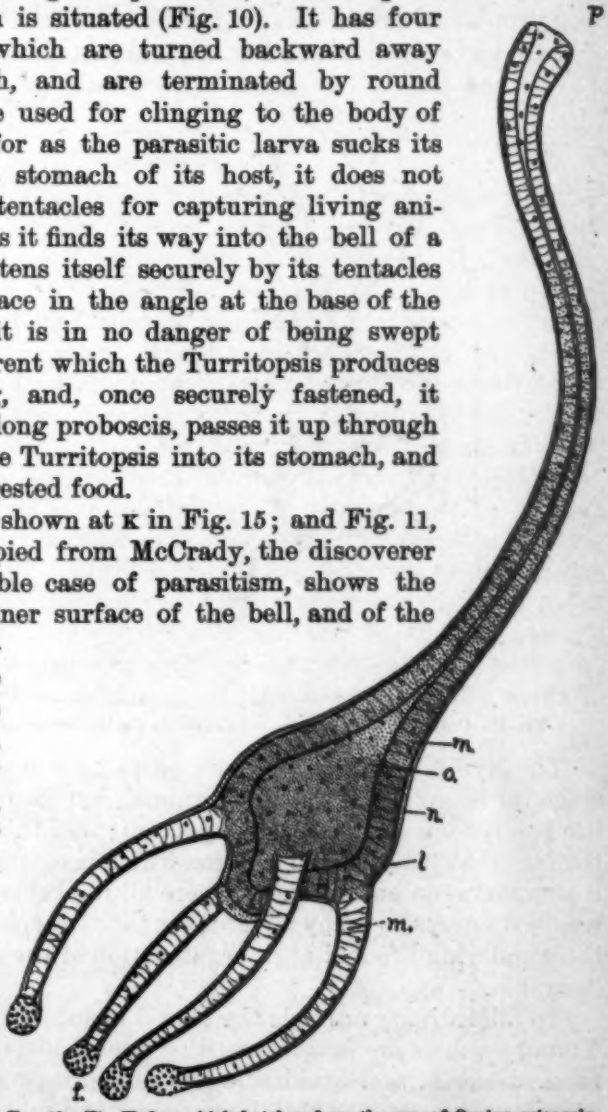

FIG. 10.—The Hydra, which hatches from the egg of *Cunina octonaria*, drawn from nature by W. K. Brooks: *o*, body; *p*, mouth; *f*, tentacles.

Thus protected by the bell, and supplied with abundant food, which it neither captures nor digests, but sucks, all ready for assimilation, into its own stomach, the larva has a very "soft thing," and is naturally in no hurry to complete its development or to seek its fortune in the open water. It grows rapidly, acquires more tentacles, and, as its stomach grows larger, and it becomes able to suck in and to assimilate more food than it needs

for its own growth, it gives rise to buds, which become parasitic hydras like itself, and remain attached to it and share all its advantages. The budding continues until a complicated colony of long proboscides, bodies, and tentacles is formed. A young colony of these larvæ is shown in Fig. 12, and an older one in Fig. 13.

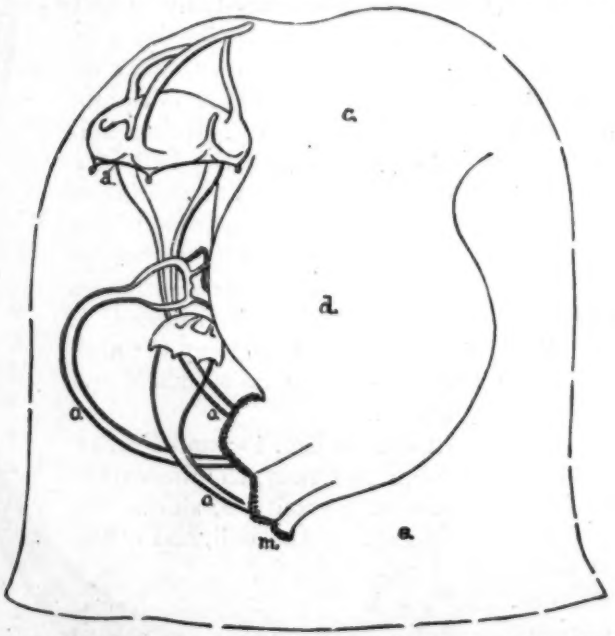

FIG. 11.—Outline of a Turritopsis, with parasitic Cunian larvæ, copied from McCrady.

The hydra larva of the Liriope is only a short transitional stage in the youth of the adult animal, but in Cunina the larval life has become vastly more important; and this is clearly due to the fact that it has found a home which is extremely favorable to it as a larva, an environment where all its wants are supplied, and where it enjoys so many advantages that the speedy acquisition of the wandering life and high organization of the adult is no longer desirable.

To all ordinary animals the period of infancy is full of danger. Young animals are encompassed on every side by peril from enemies, diseases, and accidents, and the prospect of long life increases enormously as childhood passes and maturity approaches.

Short infancy and rapid development are therefore, in ordinary cases, the conditions which are most favorable for the perpetuation of the species and the welfare of the individual: but this does not hold good of Cunina. The hydra stage has therefore been prolonged, and the larva has acquired the power to produce other larvæ to share its advantages. After a time, however, a flange or collar grows out from the body of each hydra, among the bases of

the tentacles, as shown at *e* in Fig. 13; and, folding down toward the mouth, gives rise to a swim-bell and bell-cavity. The larva is then set free, and it escapes into the water as a young jelly-fish (Fig. 14), with an enormous proboscis (*d*), a relic of its parasitic

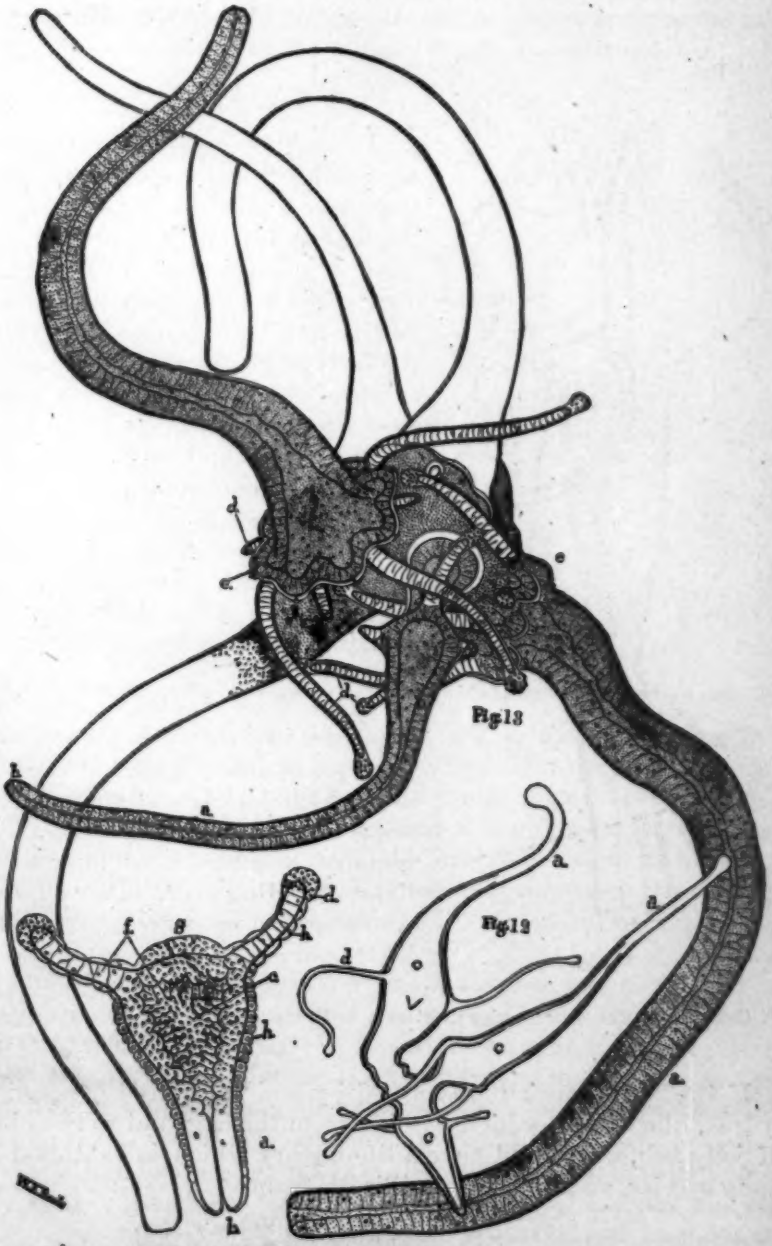

FIG. 12.—A colony of three young parasitic larvæ of Cunina.
FIG. 13.—An older colony, consisting of six Hydræ, some of which have begun to become transformed into Medusæ.

life, and a small bell (*e*), which, however, grows very rapidly, so that the animal soon assumes the adult form, shown in Fig. 9.

The life-history of this species of Cunina is given in the following diagram:

III. Cunina Octonaria.—Egg = Planula = $\begin{cases} \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \times \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \times \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \end{cases}$

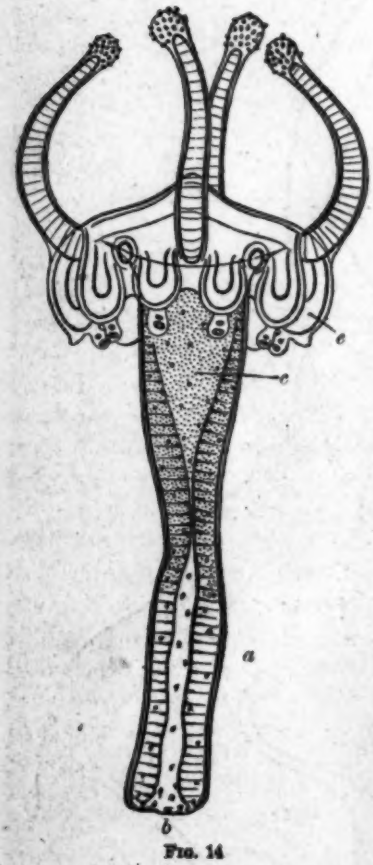

Fig. 14

The egg becomes converted into a planula, this into a hydra, and this into a medusa, exactly as in the case of Liriope, except that the case is complicated by the budding of new hydras, each of them destined to become a medusa, from the body of the hydra which hatches from the egg, during its parasitic life, and before it becomes a medusa. Each Liriope-egg produces only one adult, while the number of adults which may be derived from a Cunina egg is quite large, although every individual in the series ultimately becomes an adult, and multiplies by sexual reproduction.

In another species of *Cunina*, *Cunocantha parasitica*, a new complication is introduced, for the hydra which hatches from the egg never becomes a jelly-fish, but remains a parasite as long as it lives, budding off other larvæ which grow up into adults. Its life-history is like this:

IV. Cunocantha Parasitica.—Egg = Planula = Hydra × $\begin{cases} \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \end{cases}$

If the hydras which are formed by budding were to remain as hydras, like the one which hatches from the egg, and were to bud off jelly-fish, we should have a life-history which is exhibited by many species, and is shown in this diagram:

$$\text{Egg} = \text{Planula} = \text{Hydra} \times \begin{cases} \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \\ \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \end{cases}$$

Turritopsis, the jelly-fish, which is infested by the Cunina larvæ, has a life-history which is very similar to the one given in this diagram, with the addition of a slight but highly important modification.

FIG. 15.—TURRITOPSIS.

The planula is shown in the left-hand lower corner of Fig. 2. It soon attaches itself to some solid body and becomes a root, which goes no further, but, as shown in the right-hand lower corner of Fig. 2, soon produces a bud which becomes a feeding hydra. Multiplication by budding now goes on rapidly, in such a way as to

build up a branching, tree-like colony, with a feeding hydra at the tip of each twig. Two branches from one of these trees are shown in Fig. 15. Ultimately each of these hydras produces a number

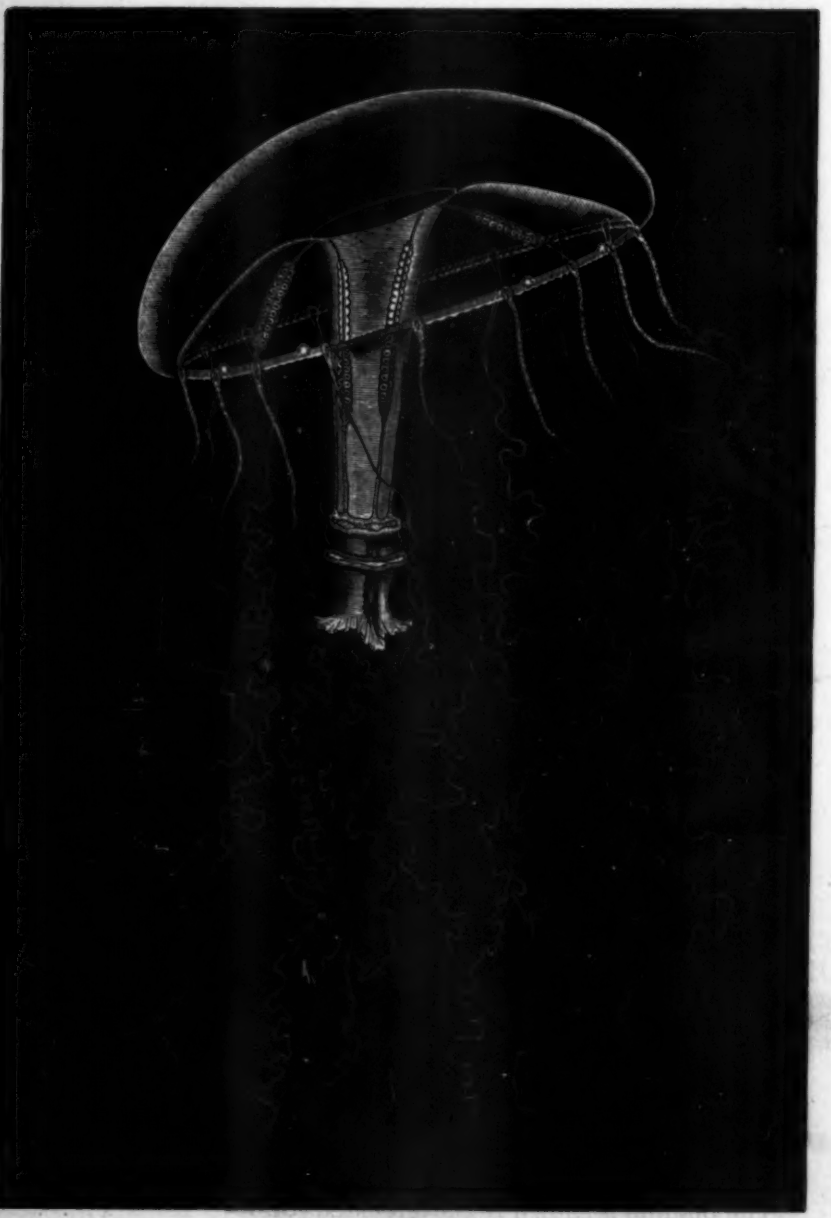

FIG. 16.—EUTIMA.

of buds around the base of its body, as shown at B in the figure, and these buds ultimately become detached and grow up into the adult jelly-fish, K.

V. TURRITOPSIS.—Egg = Planula = Root × { Hydra × { Medusa < eggs. / Medusa < eggs. } / Hydra × { Medusa < eggs. / Medusa < eggs. } / Hydra × { Medusa < eggs. / Medusa < eggs. }

The life-history of Turritopsis is therefore like this, and the chain which connects the egg with the adult is broken three times, for the root, which is directly derived from the egg, goes no further, nor do the hydras which bud from the root become jelly-fish, and the latter form still a third set of individuals.

The larval life is long and important; the number of sexual adults produced by each egg is very great indeed, and the life-history is extremely complicated, but each one of the individuals is in the direct line of succession; for, while neither the root nor the hydras ever become converted into any higher form, the root produces hydras, and each one of these produces jelly-fish.

In the next species to be considered, a Eutima which is common on our coast (Fig. 16), another stage of complexity is introduced by the restriction of the power to bud jelly-fish to certain hydras, while others become specialized for nutrition. This specialization has come about gradually, and the various species of living hydroids exhibit all the steps in the process. In some species, as in Turritopsis, all the hydras perform both functions, and are alike in structure; in others, those which are placed at the tips of the branches and are best able to obtain food devote themselves to this purpose and produce no jelly-fish, while these are budded only from those hydras which are near the base of the colony. In some cases the two sets of hydras are alike in structure, but in other species the feeding hydras at the tips of the branches are very large, with capacious stomachs and long tentacles, while the reproductive hydras have small tentacles and mouths. In still other species, as in Eutima, they are true blastostyles, without mouths, and with rudimentary tentacles, and all the work of nutrition is performed by the feeding hydras.

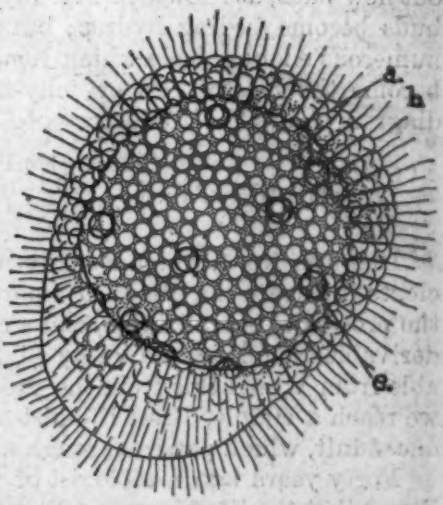

FIG. 17.

The planula of Eutima is shown in Fig. 17. After a short swimming life, it fastens itself to some solid body, and elongating, be-

comes a root (Fig. 18); and a bud, *m*, soon grows out from it to form the first feeding hydra, which soon acquires a mouth (Fig. 19, *l*) and tentacles, *i*, and begins to capture and digest food and to accumulate a reserve of nutriment, while the root continues to throw

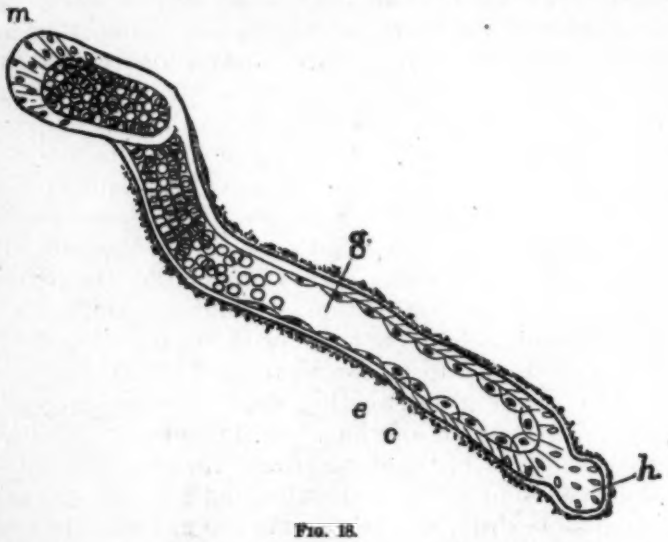

FIG. 18.

out new buds, as shown in Fig. 18 at *m*. For a long time all the buds become feeding hydras; but at last, when the mouths are numerous enough, buds which remain mouthless are formed, and become the blastostyles or jelly-fish producers. The following diagram shows the life-history of Eutima:

VI. EUTIMA.—
Egg = Planula = Root × { Feeding hydra × { Blastostyle × { Medusa < eggs.
Feeding hydra } Medusa < eggs.
Feeding hydra × { Feeding hydra { Medusa < eggs.
Blastostyle × { Medusa < eggs.

Diagram No. 1, which was given in the beginning of this article, to illustrate the life of Dysmorphosa, shows the next stage in the process of complication, and a comparison will show that it is derivable from Diagram VI by slight changes, just as VI is derivable from V, and this from the preceding, and so on until finally we reach a simple, direct life-history, in which each egg produces one adult, which passes through a transitory larval hydra stage.

Forty years ago, a zoölogist of the old school might have believed that the life-history of Dysmorphosa has always been complex, and that of Liriope always simple; but the doctrine that all the representatives of any great group of animals owe their common characteristics to descent from a common ancestor is one of the fundamental principles of modern elementary zoölogy, and as this doctrine forms the basis rather than the aim of this article, I assume, without discussion, that the remote ancestors of Liriope

and Dysmorphosa were the same, and that all the life-histories which have been described are modifications of that which was exhibited by this ancestor.

The series which has been given shows that this ancestor must have developed directly from the egg, its adult stage must have been the most important part of its life, and the hydra stage only a transitory larval condition. As, in certain lines of descent from

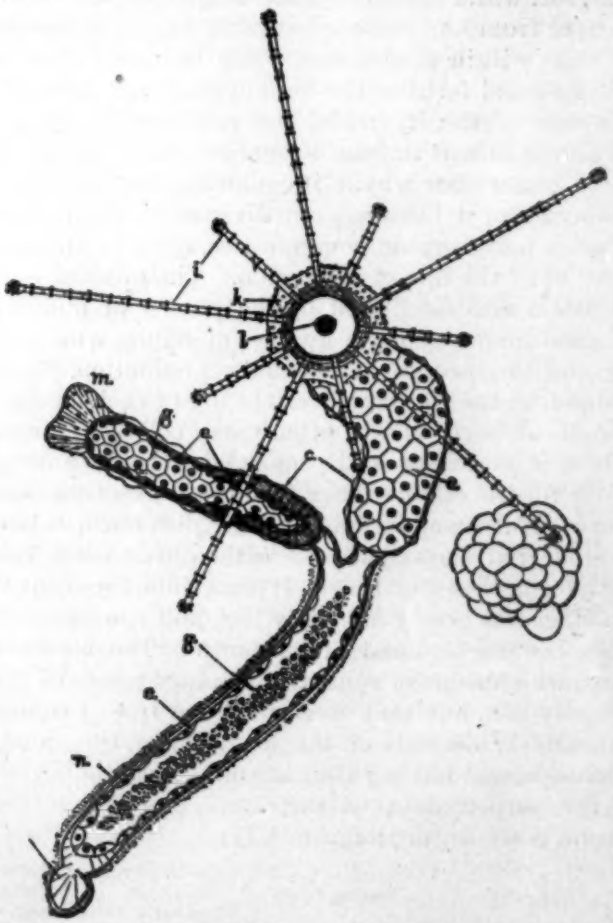

FIG. 19.—Young hydroid colony of Eutima.

this ancestor, the conditions of life became more and more favorable for the larvæ, and as successive generations of larvæ became more and more adapted to these conditions, the larval life gradually increased in length and importance, and threw the adult sexual stage more and more into the background, until, in the case of Dysmorphosa, we have a colony of long-lived larvæ, which embody all that is most distinctive and characteristic of the species,

and the adult jelly-fish lives only long enough to effect the wide distribution of the eggs, and the establishment of new colonies of larvæ.

Something very similar to this has occurred in a few insects. The caterpillar stage of most butterflies is simply a preparatory step directed toward an end, the production of the perfect insect; but the bagworm is a butterfly in which the larval life is most important, for, while the caterpillar lives long, the female insect never escapes from her cocoon, but after her final transformation lays her eggs within it and dies, while the male lives only long enough to find and fertilize the female, and then dies also.

In the case of the hydroids, the power of budding, a power which is almost absent in insects, enables the larval life to assume a degree of importance which it could not have if the larva remained simple, for it has rendered division of labor possible, and has produced polymorphic communities, most of the members of which are out of the line of succession. The gradual reduction of the adult life is also facilitated by the process of budding, as this effects a great increase in the number of adults which come from each egg, and thus secures the sexual reproduction of the species, notwithstanding the shortening of the life of each adult.

The shells of hermit-crabs often carry colonies of another hydroid, which is so similar to Dysmorphosa that a drawing of one will answer for the other. They are almost exactly alike, and it is only after careful examination that any difference between them is discovered; but, inconspicuous as the difference is, it is highly important, for in the second form, Hydractinia, the adult locomotor jelly-fish stage has been completely lost, and the whole life of the species has become centered in the larvæ. The blastostyles produce buds, which acquire some rudimentary traces of the organization of jelly-fish, but they never become free or complete their development. While still on the blastostyles, they produce eggs or spermatozoa, and having thus accomplished their purpose and secured the perpetuation of their race, they die. The life of Hydractinia is shown in Diagram VII:

VII. HYDRACTINIA.

Egg = Planula = Root ×

- Feeding hydra ×
  - Feeding hydra → Medusa < eggs.
  - Blastostyle × → Medusa < eggs.
  - Defensive hydra → Medusa < eggs.
- Feeding hydra ×
  - Feeding hydra → Medusa < eggs.
  - Blastostyle × → Medusa < eggs.
  - Defensive hydra → Medusa < eggs.
- Feeding hydra ×
  - Feeding hydra → Medusa < eggs.
  - Blastostyle × → Medusa < eggs.
  - Defensive hydra → Medusa < eggs.

This is by no means the end of the story, for the many species of hydroids without any jelly-fish stage present all stages in the gradual simplification of the sessile medusa buds, until at last all traces of the structure of the jelly-fish disappear, and they are

degraded into simple accumulations of reproductive cells—reproductive organs—on the bodies of the hydroids.

No group of animals presents a more complete record of the process of evolution of species than the hydro-medusæ, and the comparative study of the different species gives, with a wealth of detail which is entirely beyond the scope of a short article, all the steps in the progress of modification. The minute gradations are so numerous that a long training is required to grasp them all without confusion, and to read the history which they exhibit, but those which I have selected are sufficient to illustrate the manner in which the larval life has gradually grown into prominence, and has become evolved and specialized, while the adult life has dropped more and more into the background, and has finally disappeared completely.

MAN IN RELATION TO THE LOWER ANIMALS.

By Prof. EDWIN EMERSON.

ON the published bills and circulars of the "Fidelity Trust Company," of Philadelphia, is a representation of a strong-box guarded by a watchful dog. The faithful protection of the dog is a striking emblem of the mission of the Fidelity Trust Company. Fidelity to a trust is certainly a moral quality of a high order. This is such a well-known characteristic of the family of dogs as to have become proverbial. It is a matter of common observation that members of the better class of dogs, such as Newfoundlands and Saint-Bernards, show also other moral qualities: they have a high sense of honor, can not be bribed, will not steal, etc., and are true to the death as to matters committed to their trust. To deny to such animals the possession of moral qualities seems to be absurd. But moral qualities and reasoning faculties are not confined, in the animal world, to dogs alone; far from it. Many tribes of animals have the habit, when necessity seems to require, of posting sentinels to guard from surprise. This practice is in use by the chamois, the deer, the wolf, the goat, the wild horse, the elephant, the beaver, the monkey; the raven, the crow, and many other birds. To consider in advance as to the necessity of placing sentinels, and then to resort to that form of strategic device, is a decided proof of the possession of no small perceptive and reasoning power; and the fact that the sentinels faithfully fulfill the onerous duties of their trust is a striking proof of advanced moral qualities.

Any theory in regard to man's place in nature which denies some degree of reason and moral perception to the lower animals

is so wide of the facts that it must be a mistaken theory. It places man too high, and assigns to the various tribes of lower animals too low a position in the moral and intellectual scale to agree with observation. A wide and unnecessary chasm is thus placed between man and the inferior animals, when, in fact, the lower tribes of men and the higher tribes of animals, such as elephants, foxes, dogs, and monkeys, are not so greatly apart in the line of intelligence and moral perception. Savages recognize this affinity. Thus we are assured that certain tribes of negroes regard monkeys as their near relatives, who have been deprived of the power of speech on account of their mischievousness and badness.

The wonderful manifestations of instinct are so remarkable that the old theory ascribed it to God himself having directly implanted it, "from without and from above"; but that theory has been set aside by modern investigation, and it is now very generally recognized that instinct is the hereditary result of long experience. This being the case, all the manifold exhibitions of reflection and reason, and careful, self-denying affection shown by the various tribes of animals, must be ascribed to the workings of their intellectual and moral faculties through long periods of time.

Dr. Mark Hopkins, in his "Scriptural Idea of Man," teaches that man alone, among the animals upon the earth, is dignified by the possession of what constitutes him "a person." Personality, according to Dr. Hopkins, arises from consciousness, reason, and a moral nature. Consciousness is defined (p. 48) as "the knowledge of his own existence by a being who knows himself to be. . . . Thus arises a knowledge of rights and obligations. . . . Thus man is formed to rule over the lower creation. . . . From all that is below him man is most widely separated" (p. 106). "Of dominion over itself, over nature, or over its fellows, no brute can know anything; nor can it know anything of an intelligent mediation between nature and God. Being destitute of rational and moral elements, the brute can not have the first dawning of either of these ideas" (p. 103).

In reply to these statements we observe—that brutes do rule over themselves, oftentimes exhibiting remarkable self-control. Nothing is more common than for the parent animal to abstain from food until the young ones are provided for. Brutes do rule over each other—scarcely any of the gregarious animals fail to show this power; it is true of monkeys, stags, elephants, bulls, and birds in their migrations. The shepherd's dog rules over the flock committed to his care almost as well as his master As for dominion over nature, the brutes exercise just as much of it as is necessary for their well-being and preservation. A bird that builds its nest in a sheltered place exercises control over nature,

in its degree, quite analogous to the work of a human architect. "The foxes have holes, and the birds of the air have nests." How does the fox get its hole, or the bird its nest? They make them for their purposes, and this is certainly control over nature to that extent. How does the fox support his family if he has no control over nature? Do hens and chickens run into his hole and ask to be eaten? Dr. Hopkins does not seem ever to have heard of the way in which a tribe of monkeys prepare to rob a corn-field. Let us describe it. When they get ready to start on their expedition, an old monkey, the leader of the tribe, with a staff in his hand, so as to stand upright more easily, marches ahead on two legs, thus being more elevated than the others, so as to see signs of danger more readily. The rest follow him on all-fours. The leader advances slowly and cautiously, carefully reconnoitring in all directions, till the party arrives at the corn-field. He then assigns the sentinels to their respective posts. All being now in readiness, the rest of the tribe ravage and eat to their hearts' content. When they retire, each one carries two or three ears of corn along, and from this provision the sentinels are regaled on arrival at their lair. Here we see ability to rule and a willingness to submit to rule; a thoughtful preparation of means to the end in view; and a recognition of the rights of the sentinels to be suitably rewarded at the close of the expedition. Wherein does all this differ from a similar foray of a tribe of savage men? The only difference is in degree; otherwise, it is much the same. Dr. Hopkins's proposition that animals are not possessed of consciousness is mere assertion. He offers no proof whatever. A dog appears to be perfectly conscious of his existence. All his actions are in entire accordance with that view of his activity. Give him a bone, and he seems to be conscious of his rights, too, and is ready to defend them. Observe a dog of one or two years of age, and a child of four or five years, playing together; they understand each other perfectly well, and seem to get equal pleasure out of the sport. Their consciousness of existence is about the same. When the dog gets older, and accompanies his master to hunt, he understands his duties, and performs them about as well as the man performs his share. The dog hunts as truly as the man; takes a lively interest in all the proceedings; is joyous over success, and cast down in case of failure. To deny consciousness to such a being is absurd. It is quite true that the dog has not studied the Cartesian system of philosophy, and can not say to himself, *cogito, ergo sum;* but, neither can the boy who plays with him, nor, probably, the man who hunts with him. A power of analysis and metaphysical introspection is not possessed by young persons; nor, generally, by uncultivated men. They live in the present. They are satisfied with a consciousness of

existence, without prying curiously into its constituents. The power to dwell on the varying phases of the inner life, to analyze them, and to base the outlines of a system of intellectual and moral philosophy upon them, is the result of a high degree of culture and a habit of observing the operations and power of the mind.

It thus seems that what Dr. Hopkins demands as perquisites of personality, viz., consciousness, reason, and a moral sense, are all to be found, in some degree, entering into the constitution of the lower animals. If man is a person, with the accompanying rights growing out of his personality, so is an elephant a person, in his degree, and has his rights accordingly; so is a dog, or a fox, etc., each in his degree. In this manner the immense chasm which Dr. Hopkins has invented as existing between man and the lower animals disappears, and the whole realm of animated nature is restored to unity, as the product of the divine mind. This view, as Dr. Hopkins acknowledges (p. 100), is entirely in accordance with the opinions of the great majority of naturalists now living.

A few words, in conclusion, as to Dr. Hopkins's idea of man being formed for dominion over the whole lower world of sentient being. While we admit that his higher powers give him a certain amount of control over some of the lower and humbler creatures, it is to be borne in mind that innumerable millions of animals lived and roamed over the earth, through many geologic ages, before man appeared on the scene. Were they waiting all this time for their ruler? Man is a very recent animal, and does not go back, probably, further than the Tertiary period at the utmost. But, even since man appeared, his rule over the lower creation has been extremely limited. He has not exercised control over one in a million of the other orders of animals. Beyond a few animals he has been able to domesticate, his rule and kingship have been practically null. Dr. Hopkins feels this difficulty as to his theory when he says (p. 105), "In this sphere his dominion is evidently most limited and imperfect compared with what it would have been if he had not lost dominion over himself." If this is correct, it may be said in reply, that, since man has lost his dominion, it is needless to build up a theory upon the basis of his still retaining it.

PROF. TERRIEN DE LACOUPERIE believes that he can trace a direct derivation of the oldest characters used by the Chinese from the Chaldean cuneiform writing. This system, which had already become old and corrupted, came from Babylonia through Elam. Tseng-hieh, to whom Chinese tradition ascribes the invention of writing—Dung-kih, or Dunkih, in the oldest form of the name—was probably the celebrated Chaldean king Dungi, known for his numerous inscriptions, who is supposed to have lived about 2500 B. C.

HYPNOTISM: WHAT IT IS AND WHAT IT IS NOT.

By Dr. CHRISTIAN A. HERTER.

IT has so long been the custom of the world, and of scientific men, to look upon Mesmer as a charlatan, and upon mesmerism as a delusion, that it is surprising to many persons to find that men of ability and repute are now engaged in investigating the phenomena which are still known under the vague title of "animal magnetism." The fact is that the teachings of Mesmer contained a certain element of truth, although it was seriously obscured by self-deception and intentional fraud, and that this kernel of truth has already been so far isolated as to show that it is deserving of serious study.

In the pages that follow I propose to give a concise account of the present state of our knowledge about "animal magnetism," or, as it is more properly termed, hypnotism, and shall endeavor to present certain facts in their real light, which have long been misunderstood in consequence of the teachings of Charcot and his pupils. While it can not be said with certainty that there may not exist some kind of "magnetic fluid" as the cause of the phenomena I shall describe, it is certain that a large proportion of them can be much more satisfactorily explained in other ways. Moreover, there is not at present a single well-substantiated fact, so far as I am aware, which requires the supposition of a magnetic fluid, or other similar mysterious influence, as an explanation. There being, therefore, no actual evidence of the existence of any such force as "animal magnetism," the expression may justly be objected to as a misnomer, and we must seek to replace it by a more suitable term. The word "hypnotism," proposed by Braid, of Manchester, is a very good substitute, and has at least the merit of being noncommittal.

It is not easy to define hypnotism sharply. It is probably sufficiently accurate to say that it is a condition of induced sleep almost identical with ordinary sleep, in which the brain is highly and peculiarly receptive of impressions from the outer world. Ordinary sleep is often disturbed by dreams. These dreams, as every one knows, vary greatly in vividness and character. Not infrequently the objects dreamed of are of the most fantastic and unreal nature, but they are nevertheless accepted by the unconscious individual as realities, and indeed have the subjective psychological value of perceptions. The stimuli which give rise to dreams arise as a rule within the brain of the sleeper; they are spontaneous. Let us now suppose that the stimuli come from the outer world, instead of from the brain of the sleeper, and we have

precisely what happens in hypnotism. These stimuli generally consist in words spoken by the hypnotizer to the sleeping subject, who hears and understands everything that is said to him as though it was said in a dream. In many instances the hypnotized person realizes the existence of every object or person called up to his mind by the words of the hypnotizer. He sees the dog, or the man, or the house, exactly as its presence is affirmed by the speaker. He can be made to taste imaginary fluids or hear imaginary voices at the will of the physician, and, as I have just said, all these impressions are as real to him as actual perceptions. His will is so weakened that he can generally be made to execute the most varied motions at the command of the person who has put him to sleep. He may try to resist commands, but the resistance is feeble, and he eventually obeys automatically. His dreams are formed and guided by an external agency, and his muscles are brought into activity and controlled by the same influence.

The ideas, acts, and sensations which can thus be insinuated, so to speak, into the brain of a person in the hypnotic state, through the agency of speech, or any other external influence, are technically called *suggestions*.* Individuals vary greatly in the readiness with which they react to suggestions when hypnotized, and their suggestibility is said to be high or low as the case may be. In general, persons possessed of a lively imagination in the normal waking state, are highly susceptible to suggestion in the hypnotic condition. Thus the two essential elements of hypnotism are sleep and suggestion. The degree of sleep varies in different cases, from the lightest somnolence imaginable, to a condition of profound lethargy, from which the subject can only be awakened with difficulty.

Suggestibility is by no means peculiar to hypnotized persons. Almost every one is sensitive to suggestion to a certain extent when awake, for in every human being, no matter how skeptical he may consider himself, there exists a certain degree of credulity, and this credulity may be played upon and taken advantage of in a measure. Children can be made to believe the most preposterous statements if they are made with sufficient gravity. The majority of healthy children are, moreover, auto-suggestionists; that is, they create air-castles, in which they soon come to believe firmly as objective realities. Too often such auto-suggestions are regarded by parents and friends as deliberate lies. They are in reality simply the creations of phantasy, which have become established as truths in consequence of being unopposed and uncorrected by reason and experience. In the course of time the reasoning facul-

* The French use the word suggestion to express this idea, and although the English suggestion, as commonly employed, does not perfectly correspond with its use as employed by French authors, it answers the purpose better than any other word.

ties are developed and hold the imagination in check. Nevertheless, even adults are met with in whom the imagination so readily gets the upper hand that they may be induced to believe the most impossible things. I recently saw a young woman of moderate intelligence and education who was so readily influenced by suggestion in the waking state that she was unable to move from the place where she stood on being suddenly and decidedly told that it was impossible for her to budge. She could be made to see people who were in reality not present, and on the other hand could be made blind to the presence of persons and objects actually in the room. After repeatedly affirming that she was absolutely insensible to pain, it became possible to pass a needle deeply into the skin without provoking any signs of discomfort.

At first sight, these cases appear like impostures, because they are opposed to common experience, but careful examination shows that there are cases of the kind in which simulation can be pretty effectually excluded. Still, it must be admitted that simulation can readily be overlooked, and that the number of cases in which suggestibility in the waking state is so highly developed must be very small. I am inclined to look upon these higher grades of suggestibility in the waking state as pathological.

These facts have led Prof. Bernheim, of Nancy, to define hypnotism as a peculiar psychical state, characterized by increased suggestibility. In proposing this definition, Bernheim perhaps gives too little importance to the sleep which in the vast majority of cases is essential to the production of a high degree of sensibility to suggestion. At the same time there appears to be no serious reason why the term hypnotism should not be so far extended in meaning as to include those exceptional cases in which the phenomena characteristic of the hypnotic state can be produced without first inducing sleep.

The history of hypnotism is anything but flattering to the penetration and generosity of the various scientific men who during the past century have from time to time passed judgment upon the claims of its advocates, and affords a striking illustration of how the progress of knowledge may be hindered by excessive skepticism.

I can not review even the more important features of the history of "animal magnetism," interesting as it is, except in the briefest manner. The life of Mesmer is full of instruction and romance, and is well worth a careful reading; although one can not help concluding that he misdirected and prostituted his intelligence to his greed of money and love of notoriety, and that he was, upon the whole, a man of very questionable character. As is well known, the central hypothesis of Mesmer's theory is the existence of a subtile universal fluid, which he called "animal magnetism,"

in the belief that its action was in some manner analogous to that of the magnet.

In 1841 Braid, of Manchester, showed that the majority of the phenomena which Mesmer had sought to explain by means of "animal magnetism" could be just as well if not better explained without the hypothesis of a magnetic fluid. He demonstrated, in other words, that we have no reason whatever to believe in the existence of a magnetic fluid as a cause of hypnotic phenomena, and this was certainly a most important step in our progress. Braid showed that it was possible to throw persons into a condition of trance or sleep without the use of any so-called magnetic passes, and without contact of any kind. In order to induce this sleep, he simply required his patient to look fixedly at a brilliant object placed before his eyes, at the same time that he concentrated his thoughts upon the idea of going to sleep. After a variable period, generally two or three minutes, the eyes closed suddenly, the head fell to one side, and the patient was asleep. Braid found that the intensity of this sleep varied considerably in different cases, and that he could sometimes give rise to hallucinations, emotions, paralyses, etc., by simply giving the subject verbal suggestions; that is, by affirming the presence of these various conditions. The various phases of sleep induced by Braid resembled one another so much that he had no doubt they were essentially manifestations of one and the same condition. This condition he called "nervous sleep," or hypnotism.

We may justly say that Braid was the first to study the phenomena of hypnotism in a scientific spirit, and to show that they were in no way miraculous or mysterious. Still, his observations were very incomplete, for he failed to appreciate the nature of suggestion and the subtle *rôle* it plays in the manifestations of hypnotism. In consequence of this, Braid eventually confused hypnotism and phrenology in such a way as to lead him greatly into error concerning the former, and it is probable that, at the end of his life, he was much further from the truth than many years before.

After the appearance of Braid's work, the subject remained *in statu quo* for a number of years. In England, Braid was looked upon with suspicion, and had scarcely any adherents, while in France a number of scientific men became interested in his work, and contributed many observations upon hypnotism.

These observations in general confirmed those of Braid, and it was not until 1866 that Liébault, of Nancy, came to the front with new facts and original views of hypnotism. We can not follow Liébault into his somewhat vague theories of the cause of hypnotism and its various states. It is enough to say that he maintained that the different physical conditions included under

this term are determined chiefly through some form of mental action, and afford striking illustrations of the influence of the mind upon the body. This view of Liébault's is of great significance, for it is the point of departure of the supporters of the Nancy school of hypnotism, who hold that an enormous number of hypnotic manifestations can only be explained through suggestion. Liébault was an extremely conscientious and able observer. He had the courage of his convictions, and, scorned by his colleagues, lived in retirement, practicing among the poorer classes, and devoting his life to the study of the problems of hypnotism. The originality of Liébault's book, and the stimulus it gave to investigation, entitle it to be considered the most important work upon hypnotism which has appeared since the time of Braid.

In sharp contrast to the views held by Liébault and his pupils (Nancy school) stand those of Charcot and his school (school of Salpêtrière or Paris school). Charcot began the study of hypnotism in 1878, and his observations were almost exclusively made upon hysterical patients. His method of inducing sleep is similar to that of Braid. The patient gazes intently upon a brilliant object, and after a variable period falls suddenly asleep. Charcot regards hypnotism as an abnormal nervous state—a neurosis, in fact, of which there are three phases, each possessing certain well-defined characteristics. The patient may be brought from one of these stages into another at will, by means of certain skillfully performed manœuvres. The three states are known as lethargy, catalepsy, and somnambulism.

The lethargic state may be obtained either by fixation of a brilliant object, or by pressing upon the closed eyelids. The condition is characterized by the presence of deep sleep, muscular relaxation, loss of sensation, partial or complete, abeyance of the intellectual functions, and the absence of all reaction to suggestion. A curious hyperexcitable condition of the nerves and muscles (neuro-muscular hyperexcitability) is, however, present, which causes any muscle to contract when its corresponding nerve is excited by friction or slight pressure. Thus, pressure upon the facial nerve (the great motor nerve of the face) causes distortion of the features on the same side of the face.

The second stage is that of catalepsy. It is only necessary to raise the eyelids in order to transform the lethargic condition into that of catalepsy. If only one eyelid be raised, the corresponding side of the body becomes cataleptic, while the other side continues lethargic. The peculiar hyperexcitability of the nerves and muscles is absent in this stage, and the patient remains for some time in any position into which he may be put. In this stage suggestions may act through the sensibility of the muscles as a medium. Thus, if the hands are joined as in prayer, the face grows very

grave, and the patient may kneel as if to pray. Catalepsy may be converted into lethargy by simply closing the patient's eyelids.

The third stage of Charcot's hypnotic series is somnambulism. Somnambulism can be primarily induced by fixation, or may be developed out of the lethargic or cataleptic stages by light friction on the top of the subject's head. The sensitiveness of the subject to suggestions is very greatly increased. The neuro-muscular hyperexcitability is not present, and contractions can not be produced by excitation of the nerves or muscles. Light breathing upon the skin, however, gives rise to a special form of contraction which, it is said, can only be counteracted by similarly stimulating antagonistic groups of muscles. These three phases Charcot has been pleased to group under the title of the "grand hypnose," for what reason it is difficult to say, unless, indeed, it is because the description originated in Paris.

Thus it happens that, at the present day, the Paris school and the school of Liébault are the principal exponents of hypnotism. Upon many of the most essential questions these two schools stand in opposition. According to Charcot, hypnotism is a pathological condition observed chiefly in hysterical patients, which can be divided into the three sharply defined phases just spoken of. According to Bernheim, who is at present the chief representative of the Nancy school, the hypnotic state is not a neurosis, but a condition closely allied to ordinary sleep, which can be brought about in a very large proportion of perfectly healthy persons. The peculiar physical conditions described by Charcot as invariable concomitants of hypnotism, Bernheim considers the result of suggestion, and the three typical states he regards as the artificial effects of similar influences.

From a careful examination of a large number of hypnotized persons, I am forced to the conclusion that these views of Bernheim's are correct, and that the school of the Salpêtrière is in serious error. Before reviewing the facts which have led me to this conclusion, let us inquire a little more carefully into the nature of the hypnotic phenomena manifested by healthy individuals. This will greatly facilitate an understanding of the principal objections to Charcot's views.

First, as to the proper method of inducing the hypnosis or artificial sleep. This is very simple, and it is always well to assure the subject that you do not intend to make use of any supernatural means, and that there is no magnetism of any kind about your procedure. Where persons are very skeptical of your ability to put them to sleep, it is a good plan to hypnotize a few patients in their presence, as an evidence of what you are able to do. Having thus obtained the subject's confidence, the physician asks him to look him intently in the eye, and to think of nothing

but of going to sleep. The subject should be seated in a comfortable position, preferably with his back to the light. The recumbent position is not usually necessary. While the patient's eyes are still fixed, as just described, upon the operator's eyes, the latter says, in a monotonous but distinct tone: "Your eyelids are getting heavy, very heavy. Your eyes are red and moist. You are getting sleepy, very sleepy, very sleepy. Now you are nearly asleep. Your eyelids are shut; you can not open them, because you are asleep, fast asleep. Try as hard as you will, you can not open them. You can not wake up," etc. While these words are being uttered, the lids begin to drop and the eyes really look sleepy, and, if the subject is a good one, the pupils can generally be seen to dilate and contract alternately.

If two fingers of one hand slightly separated be held before the patient's eyes, he rolls his eyes down, following the fingers as they are moved down until the eyelids actually close. When the eyes close the subject is almost asleep, and a few judicious words affirming that he is asleep complete the hypnotizing.

In order to obtain good results it is necessary to watch the subject very carefully. Every sign of submission to the hypnotic influence should be immediately turned to account. Thus, if the eyes are seen to close suddenly, the subject should be at once told that he is asleep and can not wake up. If, instead, the operator adheres to a rigid formula, he may affirm the presence of sleep too soon, and the subject loses confidence, and the trial fails. *The great secret of success is to watch closely, and suit the words to the symptoms of sleep as they develop.* The importance and the difficulty of doing this well can only be appreciated after trial.

The *rationale* of this mode of hypnotizing is very simple. It consists essentially in an imitation of the processes of ordinary sleep by means of verbal suggestion. The attention is fixed by making the subject look into the physician's eyes, which thus answer the same purpose as Braid's glass knob. The heaviness of the eyelids, the dryness and subsequent moistness of the conjunctiva, and the gradual approach of somnolence, are natural episodes which usher in ordinary sleep. These we actually bring into existence by acting on the imagination through speech. It is a case of verbal suggestion in the waking state. The skill of the hypnotizer consists in making the subject believe he is going to sleep; that is all. It is not necessary that he should possess any peculiarities of temperament and voice, as has been supposed. Strokes and passes are useless, except in so far as they heighten suggestion. In short, everything lies in the subject and not in the hypnotizer. *Nobody can be hypnotized against his will.*

The persons who prove most refractory are so because they either consciously or unconsciously resist the operator's influence.

They are not passive. Persons who are very much preoccupied with a certain idea are difficult to influence; hence hypochondriacal and hysterical patients make poor subjects, largely on account of their introspection and egoism. Many people think that it is a sign of weak will to yield readily to hypnotism, and that it is a sign of strong character to resist. Both views are equally erroneous. I have frequently seen persons of strong, determined character fall asleep at the first trial. On the other hand, hysterical patients with very little will-power are generally highly refractory. Men are as readily hypnotized as women. Imaginative persons, and those who sleep very soundly, are generally easily hypnotized.

It has been repeatedly stated that frequent hypnotization is dangerous. It is questionable whether hypnotism has ever proved really dangerous, even when it is induced as it is at the Salpêtrière. With Braid's method, it often happens that a severe headache or general nervous irritability is produced, and hysterical or epileptic paroxysms are occasionally brought on in persons subject to them. It is important to understand that these evil results are not due to the hypnosis; they are the result of the long fixation. Liébault, Bernheim, and Forel have hypnotized many thousand persons in the manner I have described—that is, by suggestion—and have never witnessed an unpleasant or harmful after-effect.

It is impossible to give an exhaustive description of the hypnotic manifestations here. The most that can be done is to mention briefly the principal classes of phenomena with which one meets; and, having done this, some of the more remarkable ones can be studied by themselves.

Liébault divides hypnotic sleep into six grades. The division is arbitrary and theoretical, and the grades can not be sharply separated from one another, for there are all imaginable transitions. Nevertheless the classification is useful, and I shall give it here as the best means with which I am acquainted of introducing the characteristics of hypnotism.

Under the first degree Liébault includes those cases in which the somnolence is so slight that it is questionable whether it can really be called sleep. There is a sense of drowsiness, often very pronounced, and the eyelids feel heavy, but this influence may only continue while the operator is speaking. As soon as his influence is withdrawn the subject wakens.

In the second degree the subject's eyes are closed. He hears everything that is said to him or that occurs about him, but does not awake spontaneously for some time. As the magnetizers say, he is in the "hypotaxic" or charmed condition.

This degree of hypnotism is characterized by the existence of what is called suggestive catalepsy. If, as soon as the subject is

asleep, one of its arms be lifted, it will remain, in a certain number of cases, just where it is put. It is rigid, and resists any attempt to change its position; that is, it is cataleptic. The phenomenon is called suggestive catalepsy, because it is the result of suggestion and is not spontaneous. The arm is lifted into a certain position; it remains, because the act of putting it there—the suggestion—insinuates into the mind the idea of keeping it there. The psychical process which determines this phenomenon is purely automatic. The will does not come into play.

It often happens that patients whose sleep is no deeper than that just described imagine, upon waking, that they have not been asleep, because they remember what has been said to them; or they think that their somnolence has been due to their desire to be obliging. If they are again hypnotized, the catalepsy can be made to reappear, although the subject may have previously avowed his intention of preventing it.

In the third degree the phenomena just described are present, but the sleep is deeper than before. The sensibility to pain is nearly or quite abolished, and can generally be entirely abolished by verbal suggestion. The physician says authoritatively, "Your hand is dead and can no longer feel anything," and he may then puncture the skin with a needle, and the subject shows no sign of pain. Automatic movements of various kinds can be produced in this stage. The arms may be made to rotate about one another, and the subject may be dared to stop them, but he can not. He hears and remembers everything that is said to him.

All these phenomena are present in the fourth degree, but, in addition, there is loss of relationship with the outer world. The sleep is so deep that the subject only hears what the hypnotizer says. He is in relation with the hypnotizer and no one else, but may be switched off, so to speak, into relationship with any one else at pleasure.

The fifth and sixth degrees are distinguished by forgetfulness of what has happened, or amnesia, upon waking, and constitute somnambulism.* In the fifth degree the amnesia is not complete. The patient still vaguely remembers what has been told him, or may have a confused recollection of what has occurred during a certain period of his sleep, while he may have completely forgotten everything else.

Persons who exhibit this degree of sleep are extremely sensitive to suggestion. They may be made cataleptic and absolutely insensible to pain. They can be made to execute the most varied auto-

* The word somnambulism is commonly used to designate sleep-walking. As used in hypnotism, it has the more extensive meaning of forgetfulness after waking from hypnotic sleep. Very often, however, this amnesia is associated with such highly developed automatic movements that the person is able to walk about.

matic movements, and to experience hallucinations and illusions of the senses. A solution of quinine is drunk with every show of satisfaction if the operator merely states with sufficient emphasis that it is a delicious cup of chocolate.

The fifth degree of hypnotism is known as light somnambulism. In deep somnambulism (sixth degree) the subject has no memory whatever of what has passed during the sleep. There is absolute amnesia. Nevertheless he can hear and obey suggestions with great readiness. There are cases of deep somnambulism, however, in which there is scarcely any suggestibility, and in which all the senses appear to be in temporary abeyance.

The above description of the various grades of hypnotism is far from satisfactory, for every person preserves in some degree his own individual peculiarities and impresses them upon the hypnotic state, and this gives rise to an almost infinite number of varieties which overlap one another in every imaginable way.

The proportion of somnambulists to the total number of persons who can be hypnotized is large, being about nineteen per cent in adults. Sex seems to be an unimportant factor, contrary to what was formerly supposed, for the preponderance in favor of women is only about one per cent. The proportion of somnambulists among children is much higher, being about twenty-six per cent in children from one to seven years of age. More than half the children between the eighth and fourteenth year are somnambulists.

I have heretofore only spoken of the phenomena which are present during the actual sleeping state of the hypnotized subject. In addition to these, there is a class of manifestations which make their appearance after the subject has awakened. These post-hypnotic phenomena, as they are called, are the result of suggestion, and can only be produced in somnambulists. The manifestations themselves only differ from those of somnambulism in that they persist, or only take effect, after the subject awakes. Thus, we can suggest post-hypnotic acts, illusions of the various senses, and hallucinations. For example, a good somnambulist is hypnotized and told that on awaking he will commit a certain act, that he must commit it, and can not offer any resistance to his desire to commit it. Accordingly, when he awakes he executes the suggestion which has been insinuated into his mind, either literally or with some slight modification, and, not having any recollection of what has been told him, believes that his act is spontaneous. These cases afford the best illustration I know of the relativity of our freedom of will, and of the truth of Spinoza's saying, that our consciousness of free-will is but ignorance of the causes of our acts. If the act which has been suggested is one

which might readily be committed spontaneously, the subject makes no comment upon it. If, however, he has been told to do something ridiculous, he is usually a little ashamed of his act, and looks silly and embarrassed; or, if asked why he did such a foolish thing, he invents a justification of some kind, and these excuses are often exceedingly amusing.

It is possible, moreover, to give rise to post-hypnotic illusions and hallucinations of the various senses. Hallucinations of sight are perhaps more readily provoked than any other kind. A person may be made to see a rose, a bright light, a cat, or a devil. In short, in some persons almost every imaginable visual hallucination may be provoked. Binet and Féré have tried to demonstrate the peripheral character of visual hallucinations, by showing that such hallucinations are doubled when the patient looks through a prism. If, for example, a person has an hallucination of a rose, he sees two roses on looking through a prism. Bernheim has shown conclusively that this discovery of Binet and Féré is the result of an imperfection in their manner of experimenting, and that in reality a prism produces no effect whatever on the hallucination. In experimenting on hysterical patients, however, it is very easy to be deceived with reference to this point, for when the prism is placed before their eyes they see at once that everything looked at through it appears double, and conclude, with hysterical shrewdness, that the hallucination ought to be doubled likewise. In other words, they either consciously or unconsciously apply their newly derived knowledge of the effect of a prism to the hallucination.

This assertion is supported by the following facts: If an hallucination be called forth by suggestion in a hysterical patient, in a room which is sufficiently dark to make the objects it contains nearly or quite invisible, the hallucination is not doubled in looking through a prism for the first time, for the subject is unconscious of the fact that the glass through which he is looking has the property of doubling the image of a real object. Repeat the experiment in a light room, and the patient will state that she sees the hallucination double. If the subject of the trial be an unsophisticated child, and not an hysterical woman, the hallucination is in every instance single.

The duration of post-hypnotic hallucinations varies considerably in different cases, but is usually not greater than a few minutes. Instances are, however, recorded where they have lasted hours, and even days. It must be remembered that post-hypnotic hallucinations can only be induced in a moderate proportion of somnambulists.

I can not omit a few words about the state of the circulation and respiration during hypnotic sleep. Braid noticed that, when

a subject was hypnotized, the pulse was at first slowed, but afterward accelerated, and he attributed this acceleration to the occurrence of cataleptic rigidity of the muscles. He also observed that the respiration was increased in frequency, and sometimes became difficult. Later observers have made numerous experiments, some of them very carefully conducted, in order to settle these points, and their results in general support Braid's conclusions. These investigators, however, employed Braid's method of hypnotizing, and this fact vitiates their results, because the continued fixation on the glass knob requires a good deal of physical effort, tires the eyes, and gives rise to a certain amount of emotion, particularly in subjects who have not been previously hypnotized. In consequence, there is a physiological increase in the rapidity of the pulse and respiration, not unlike that which some persons experience when being examined by a physician, and which are therefore to be regarded as the effects of emotion and fatigue, rather than of hypnotism. This view receives confirmation from the fact that subjects who are hypnotized by the suggestion-method of Liébault and Bernheim seldom exhibit any alterations in the rhythm and rapidity of the circulation and respiration. I say seldom, because it does sometimes happen that a nervous person experiences an acceleration of these functions when hypnotized for the first time, even when the suggestion-method is employed.

There are also rare cases of somnambulism in which it is possible to modify the pulse-rate by means of suggestion. Thus, Beaunis reports a case in which the pulse registered ninety-eight beats per minute during the sleep and was reduced to ninety-two per minute by a suggestion of decrease. Then the heart, having recovered from the effects of suggestion, returned to its previous rate of pulsation, and a suggestion of increase resulted in an acceleration to one hundred and nineteen beats per minute.

There are exceptional cases of somnambulism in which it is possible to produce the most astonishing effects upon the circulation of the blood at the surface of the skin by suggestion. Nosebleeds have actually been produced in this way, and in several cases real blisters were caused. In one of these cases eight postage-stamps were applied to the shoulder during hypnotic sleep, and the suggestion was given that a blister was being applied. The subject was allowed to sleep all day, and on the following morning the stamps were removed. The skin under the stamps was found to be thick, wrinkled, and yellowish white, over an area of from four to five centimetres in diameter, and around this space there was a zone of intense redness. By four o'clock of the same day, four or five small blisters had appeared, and fifteen days later evidences of inflammation were still present. This case

was observed by Bernheim himself, and there are others of like nature reported by equally competent observers.*

I have tried to show how essential a *rôle* suggestion plays in determining the various phenomena of hypnotism. Let us employ the facts we have gathered as the basis of an examination into the views which have emanated from the Salpêtrière.

As already stated, the experiments of Charcot have been made chiefly upon persons suffering from hysteria, and it is well known that those who suffer from this disease are more prone to every form of deception and simulation than any other known class of beings. Hence we may safely say that it was unfortunate to choose such persons for the subjects of a physiological investigation, particularly as most of the hypnotic phenomena are of a subjective and not of an objective character.

The number of persons in whom the "grand hypnose" already spoken of has been induced at the Salpêtrière is very small, being thirteen in ten years, according to Binet and Féré. These subjects have been regularly hypnotized and experimented upon for a long period of time, and the process has become second nature to them. They have been prepared, and phenomena which they exhibit are in most instances the result of many years of a peculiar kind of culture. They do many remarkable things at the operator's will; but these ought not to be considered as characteristic hypnotic manifestations. It is much more correct to look upon them as hypnotic tricks, if I may use the expression. A patient is hypnotized and goes into the so-called state of lethargy. A bright light is held before the eyes, the eyes are opened by the operator, and the patient is cataleptic; but no one can pretend to say that the catalepsy thus induced is characteristic of hypnotism. The subject has become cataleptic through a sensorial suggestion —the bright light—simply because she has learned to do it, probably by seeing other patients similarly affected or by hearing the operator speak of the effects he expects to get. Take a healthy person and hypnotize him. When he is sound asleep, open his eyes with a bright light before them and observe whether he becomes cataleptic or not. Either he simply wakes up, or his lids close again and he relapses into sleep. It is possible that in very rare instances spontaneous catalepsy may make its appearance, but it is always difficult to surely exclude the influence of suggestion by word, gesture, or imitation. Even in hysterical patients the cataleptic state may be dissolved or prevented by the use of suggestion.

MM. Binet and Féré, Prof. Charcot's assistants, imagine that

* Although I have never seen the effects of suggestion carried to this point, I have several times seen distinct localized erythema created through repeated and energetic suggestion.

they have eliminated the effects of suggestion because they make their experiments in their so-called cataleptic and lethargic stages. They say, "These (stages) are unconscious stages of the 'grand hypnose,' stages in which the condition of the senses and intelligence renders the subject a perfect stranger to what is going on around him." Nothing could better illustrate the imperfection of their method of research, for, as we have seen, some knowledge of what is going on is retained in all but the most exceptional cases.

The number of non-hysterical persons hypnotized by Liébault, Bernheim, and Forel is very great. Yet not one of these observers has ever been able to obtain the results of the Paris school except through the use of suggestion.

The use of a bright light or the simple opening of the lids to produce catalepsy, and the friction of the head to produce somnambulism, have been found absolutely unnecessary by these observers, no matter whether the patient has been hypnotized by Braid's method or by the suggestive method. As we have already seen, all that is necessary to produce catalepsy is to lift the arm or affirm the existence of rigidity. If the sleep be profound enough, the automatic movements which usually occur in somnambulism can be provoked by simple suggestion, *and, if the sleep be not sufficiently deep, no amount of friction of the head unaided by suggestion will produce somnambulism.*

We may safely conclude, therefore, that in reality the "grades of the hypnotic series" do not exist as such. There is no sharp line of demarkation between the so-called lethargic, cataleptic, and somnambulistic stages. *The existence of catalepsy and somnambulism is dependent entirely upon the degree of sleep and the nature of the suggestion.* I do not mean to say that the Charcot school have described what they have not seen, but it seems probable that they have misinterpreted what they have observed, and have not taken into account the influence of suggestion in producing the conditions which they hold to be spontaneous. That they have succeeded by repeated hypnotization and either intentional or unintentional suggestion in reproducing a condition in their subject close akin to a neurosis I am fully convinced; but I hold that a state obtained in this way should not be taken as a basis for a description of hypnotism.

If the thirteen cases of the "grand hypnose" at the Salpêtrière were the only examples known of the effects of hypnotism, there might be some justification for looking upon them as typical examples; but to do this in the face of many thousand cases of hypnotism induced in non-hysterical persons and presenting uniform characteristics of a widely different nature, seems to be a one-sided position to say the least. I have no desire to detract from

the just reputation of one who has done so much to advance the science of medicine, but I believe that in reference to the subject of hypnotism Charcot has committed a serious error in regarding a neurosis which is unquestionably an artificial derivative of hypnotism as the type of hypnotism itself, and it seems probable that this error is largely due to a failure to appreciate the subtle *rôle* of suggestion.*

We have now reviewed the more important facts at present known about hypnotism. Into the question of cerebral physiology I can not enter here, for I desire to confine myself to facts, and we can not go far into that realm unless we give ourselves up to speculation and abandon the surer footing of facts entirely; nor can I stop to speak of the interesting phenomena of spontaneous double consciousness, of retroactive hallucinations, and of spontaneous somnambulism. Full descriptions of these and of many other interesting conditions can be found in the more recent treatises upon hypnotism.

The medico-legal aspects of hypnotism have recently been very carefully studied, and only a short time since a special treatise appeared upon the subject. The forensic questions suggested by hypnotism are certainly of great interest, but I can not help thinking that their actual importance has been considerably exaggerated. The problem is such a novel one and suggests so many curious possibilities that it is not strange that some persons should have had their mental equilibrium a little disturbed from speculating about it.

In conclusion I wish to make a few remarks about the value of hypnotism in the cure of disease. This is a subject upon which the greatest difference of opinion at present exists among professional men, but there can be no question that the majority maintain an attitude of the most rigid skepticism. That it is very difficult at present to form an exact estimate of the therapeutic value of hypnotism is certain, but I can not help believing, after careful observation of a considerable number of cases in which it was tried, that the virtues of hypnotic suggestion are real and great. To be sure, the class of maladies in which benefit can be expected is limited. There is no evidence at present that organic states of disease can be in any way modified by hypnotism, and it is not probable that there ever will be. But there is evidence, and evidence of the best kind, that a large number of functional diseases have been benefited and even permanently cured. Liébault, Bernheim, and Forel have succeeded in curing, or at least in improving, such conditions as headache, functional disturbances of the bladder, St. Vitus's dance, writer's cramp, migraine, neuralgia,

* I recently had an opportunity of studying the cases of the "grand hypnose" at the Salpêtrière, and my belief in the correctness of Bernheim's views was fully confirmed.

sleeplessness, constipation, diarrhœa, and certain manifestations of hysteria. Still, I do not wish to imply that hypnotic suggestion is of use in all forms of functional disease. In a large number of trials of the influence of hypnotism upon the insane, Forel found that the insanities supposed to be unaccompanied by anatomical changes in the brain were as little benefited as those which are known to be the result of actual brain-disease.

The majority of the insane are difficult or impossible to hypnotize. Yet, with insistance, it is possible to influence a small proportion of cases, and to even temporarily abolish hallucinations; but in general the results are unsatisfactory. In a series of experiments made to determine the effect of suggestion upon the fixed delusions of the form of insanity popularly known as monomania, it was found that the delusions could occasionally be driven away for an instant during sleep—that is, the patient could be made to renounce them; but in every instance they were present to their fullest extent as soon as the hypnotic influence wore off.

Chronic alcoholism is one of the conditions in which the most gratifying effects have been obtained by therapeutic suggestion. In several instances the habit of drinking was permanently broken, and all desire for alcohol destroyed by means of energetic suggestions against its use. The habitual use of morphine, chloral, and cocaine has been similarly overcome. The constant surveillance of such patients, afforded by an asylum, is of course an important auxiliary feature in determining such cures. One must not speak with too great certainty as to the permanency of these cures, for the cases have not been under observation long enough to preclude the possibility of relapse.

In a few cases, certain bad habits in children have been broken through suggestion, and I am confident that hypnotism has an important application here.

The frequency and duration of the hypnotic sittings, as employed for the cure of disease, vary with the character of the ailments. In chronic alcoholic disease, for example, the patient should be hypnotized every day for at least half an hour, and it is generally many weeks before much benefit can be obtained. On the other hand, attacks of neuralgia or migraine may sometimes be cured at a single sitting. I recently saw a case of spontaneous somnambulism in a young girl cured in this way. The patient was in the habit of walking in her sleep, and had been under treatment by physicians for a long time, but none of them had succeeded in doing anything to improve her condition. Finally, she was brought to Prof. Forel, was hypnotized and treated with energetic suggestion, directed against her sleep-walking. Six months have elapsed, and the somnambulism has not once reappeared.

The exact indications for the use of hypnotism have not yet been determined, but it seems probable that functional nervous disorders will be one of the classes of cases in which it will always be most successfully used.

In order to get the best results in any individual case it is important to make all the suggestions in the somnambulistic state, in which there is amnesia upon waking. Otherwise it is impossible to obtain such complete control over the patient's mind.

Such, then, are the uses of hypnotism as we at present know them. Unfortunately, there are abuses also. I have said that, when properly employed, hypnotism is absolutely harmless. When, however, a nervous or hysterical woman is repeatedly hypnotized for half an hour at a time, for the purpose of exhibiting her powers to an inquisitive public, the case is different, and I believe that the patient is harmed physically, mentally, and morally. Unfortunately, traveling "magnetiseurs" are not the only persons who give such exhibitions. I was recently present at a public demonstration of hypnotism in Paris, given by a well-known French physician under the name of a scientific lecture, which was nothing more than a vulgar unscientific catering to the curiosity of an equally vulgar and unscientific public. If a law similar to that of Belgium, prohibiting such abuses of hypnotism, were immediately carried into effect in other civilized countries, I believe there would be a timely prevention of much mischief. As it is, the matter will probably be overlooked until enough harm has been done to convince thoughtful persons that some decided measure is necessary to prevent injury at the hands of ignorant or unprincipled persons.

ETHICS AND ECONOMICS.

By ROBERT MATHEWS.

WHATEVER else the theory of evolution has done for human thought, it has at least added two phrases to our current literature that, by the frequency of their use, have done much to mold opinion into harmony with the ideas that are supposed to underlie them. Open any magazine or journal of the day, and one is almost sure to find on some of its pages "the struggle for existence" and "the survival of the fittest." The wide acceptance of the Darwinian hypothesis, of which these phrases are the embodiment, has naturally caused them to be applied to the predominant form of social conflict—industrial competition. In thus applying them, we have also brought with them ideas derived from the study of the way in which the struggle for existence has gone on in the past. The survival of

the fittest seems to have always been the survival of the strongest, keenest, swiftest, or the shrewdest, sharpest, most cunning and crafty. Nature, in selecting, seems to have no pity for the weak. She crowds remorselessly to the wall all who are not capable of sustaining themselves.

The analogies between physical life and social life are so striking, that it is perhaps not wonderful that political economists have applied this law of selection to the struggles caused by industrial competition. And when teachers and thinkers have so applied it, it is still less strange that, in the actual conflicts of industrial life, many men have adopted it as a rule of conduct. Indeed, if it be maintained that the science of political economy rests upon self-interest, and that its predominant force is competition, it would seem to be only a logical deduction that the struggles of trade must go on in a similar manner, and with similar results, to those that have occurred among animals. Even if it be urged that enlightened self-interest teaches that in the long run the welfare of the individual and the welfare of his fellow-men coincide, yet it may be replied that this coincidence is not complete and universal; and that, when self-interest is subjected to the stress of competition, it is very apt to result in pure egoism. Shall we, then, conclude that the rivalries of business, being but another form of the struggle for existence, must be carried on in the same spirit, generating like qualities, and for similar ends, as those which have accompanied the development of physical life; that material progress can only be assured by the big fish eating the little fish? This is not a comforting conclusion to reach, but the important question for us is, is it true?

Accepting the law of the struggle for existence as applying to life in all its phases from low to high, we have first to note an important difference between physical and social life. The laws governing the first are inexorable; that is to say, the organism affected can do nothing to determine the result. But in the social life of men their volitions are part of the necessary conditions. Herein lies an important difference between the methods of the simpler and the more complex sciences. For, "as Comte acutely pointed out, in the simpler sciences our object is gained if we can foretell the course of phenomena so as to be able to regulate our actions by it; while in the more complex sciences our object is gained when we have generalized the conditions under which phenomena occur, so as to be able to make our volitions count for something in modifying them."* In the physical sciences the method of study is to *eliminate one by one the conflicting conditions*, until the necessary condition is reached and the true cause discovered. In the social sciences the method consists

* Fiske's "Outlines of Cosmic Philosophy," vol. ii, p. 170.

in *generalizing all the conditions* until a more complete knowledge of them enables us to make our volitions count as a factor in determining the result. In other words, simplifying the problem in the latter case does not lead to true conceptions, as in the former, for the reason that in the social organism the interdependence of all the parts makes it essential that we study them in combination, as by the elimination of any that are important we get another organism, and not the one we are studying.

In the physical sciences, also, exact prevision is possible, because the forces considered are permanent and reliable, and never self-directing or animated by a conscious purpose. But, in the social sciences, some of the forces concerned are, within limits, self-directing and self-conditioned. Hence, exact prevision becomes impossible; but what we lose in this way is in part counterbalanced by our own ability to modify phenomena through volition and by an exact knowledge of other conditions, so as to bring about a desired result.

We have next to note a difference in the meaning we should ascribe to the "survival of the fittest" when we use the phrase in connection with social growth. It is apparent that what we should now have in mind is the survival of the socially fit. Adaptation of organism to environment means harmony with the conditions of life which surround it, and social growth is made possible only by the development of those qualities of mind and body which are both a cause and a consequence of living in society. It is obvious that such traits of character as are the outcome of a fierce struggle for individual existence would necessarily hinder, if not entirely prevent, social development, and that the fact that society is the prevailing form of human organization indicates that along with the fierceness, the intelligence, and the skill which past struggles have produced in man, there have also grown up certain moral traits which must have been even more powerful in determining the character of the social organism, than their opposites.

For the purpose in hand, we desire to call attention to the necessity of basing our political economy on moral rather than on selfish instincts. Powerful though the latter be, they are more or less anti-social in their nature, and therefore would not, of themselves, favor economic growth. That depends for its development on social growth, and it is only when the selfish instincts are held in due check and subordination to the higher impulses that the latter is possible. Strength, keenness, and shrewdness are important factors in determining the survival of the individual, and, in so far as they do this, they favor also the survival of the race. But of more importance still are those traits which, by enabling men to live together in peace, render possible the

organization of labor in such a manner as to secure the greatest economic return. In a word, our political economy, which has been unmoral, must be made moral, if it is to be the science which shall direct men into the proper paths for the production and distribution of wealth.

In determining the character of ethical economics, it is necessary that we should have some principle to guide us in directing its course. This has already been hinted at in the suggestion that it is by the survival of the socially fit that economic growth is furthered. Now, society is an organism made up of mutually dependent parts, and for its existence a certain social order is necessary, and all actions which militate against that order are more or less immoral, according to the degree in which they detrimentally affect it. Conduct which tends to lower social vitality we hold to be bad, that which tends to raise it we consider good; and every practical attempt at reform proceeds upon this basis. Such changes involve alterations in the social constitution, and the production of an organism whose relations to the conditions of its life will differ from that which preceded it, and our test of the morality of the change will be its utility, "in the sense in which utility means fitness for the conditions of life." Hence, our test of ethical economics is social well-being. Let us subject the working of the strongest economic force to this test.

Industrial competition does not engender a struggle for existence, but rather a struggle for subsistence, and generally a struggle for a subsistence of a particular kind. Where the standard of living is high and the wages of the workingmen correspond to it, it is obvious that, other things being equal, the laborer who is well fed and well clothed will produce more than if under-fed and scantily clothed. The human body, like the steam-engine, depends upon heat for its motive force, and food is its fuel. A certain amount of food is absolutely essential to life. A small increase renders man capable of doing a little work. If, now, we add twenty-five per cent more heat, we get much more than a quarter more work. We probably double the economic energies of man. Let us double his supply of food, give him "a liberal, generous diet, ample to supply all the waste of the tissues, and to keep the fires of the body burning briskly, generating force enough to allow the laborer to put forth great muscular exertions through long periods of time,"* and we reach a high degree of economic efficiency.

There is, of course, a limit to this increase of food beyond which power is not increased proportionately, and, indeed, too great an increase may do harm rather than good; but it is a general rule that raising the standard of living in one direction

* "Political Economy," Walker, p. 49.

tends to raise it in others, and eventually in all directions, and while this may not increase the individual's power of production directly, it may do so indirectly, by raising the scale of intelligence, and creating new desires, particularly for those immaterial products which it is the peculiarity of a high civilization to furnish in increased proportion as compared with the elementary and material utilities. We do not always class these as wealth, but they are, nevertheless, some of its highest forms, and are important factors in advancing civilization.

But let us now suppose that the standard of living is lowered, through a succession of bad harvests and bad years, or through the importation, in numbers large enough to seriously affect the labor market, of laborers from outside, with a much lower standard of living, and who can work for much lower wages, or from both causes combined, or from many others, such as bad laws, lack of sympathy for our fellow-men, etc., and what will be the result?

In the struggle for existence, the weaker go to the wall, and are killed and removed from further participation in the conflict. The fittest only survive, and the result of the conflict is to leave them more capable of taking care of themselves. But this is not a necessary outcome of the struggle for subsistence, unless it should be carried on long enough to become a veritable struggle for existence, which rarely occurs. On the contrary, men are not killed and thus got rid of as further competitors. They are made miserable, less fit to work, and incapable of that mobility which, if present, enables the social organism to so distribute the blows that fall upon it as to cause it the least trouble, and to render recuperation easier. "When the mobility of labor becomes in a high degree impaired, the reparative and restorative forces do not act at all." On the contrary, "industrial injuries, once suffered, tend to remain." * The constitution of society becomes impaired. The standard of living for large masses of the people is lowered, but competition is not thereby destroyed; it is more frequently intensified. Unlike the struggle for existence among animals, the economically and socially fit do not kill off the unfit, and so have the field to themselves.

Do not understand me as condemning competition altogether. Its advantages are many and great. Material progress would have been impossible without it, and under certain conditions it works out a moral result which it would be difficult to bring about by any other social force. But, tried by the test of social well-being, competition is shown to have certain inherent limitations which we must ever keep in mind. It is only by studying economics in close relation to ethics that we can do this, and it is

* "Political Economy," Walker, p. 275.

our purpose now to search for the ethical laws or principles that should govern economic practice.

If there is any one thing that both theory and practice have shown to be of economic advantage to man, it is the existence of private property. So essential is property to social welfare that, as some one has said, "if it did not exist, it would be necessary to invent it." If effort were not rewarded with results, if men were deprived of the fruits of their labor, they would soon cease to work. No thriving society exists without personal property, and, no matter how selfish were the motives that induced its accumulation, the possessor can not amass or dispose of it without conferring some benefit on his fellow-men. Where property rights are not secure, you find lack of energy, rapacious usury, and deep misery. Where these rights are recognized and protected, you have industrial activity in every direction. Men become alert, vigilant, and independent; watchful of their rights, and jealous of their freedom. In their desire to gratify their own wants, which the right of personal property secures to them, they study to supply the wants and desires of others. Thus it becomes the strongest stimulus to production, and the mass and variety of material goods now existing may be said to be the result of this stimulus. Surely no one will question its beneficence.

The earlier economists assumed that the right to private property was a natural right, or primary truth, which needed neither explanation nor defense. This was the general opinion, and, to a great extent, it is still the prevalent opinion. But the great increase in wealth that has occurred, and the lodgment of large masses of it in the hands of a few, coupled with the existence of vast numbers of poor who with difficulty manage to secure just enough to live upon, have brought up the question of the distribution of wealth. As a result, objection has been taken both to the right of private property and to the fact itself. This objection has not been confined to theorists, but large bodies of men, through various schemes of communism or socialism, are endeavoring to either get rid of private property altogether, by making it all common property, or through limiting the right of holding it, by making the state the only possessor of many of its forms.

Ability has not been lacking in the proclamation of these objections, and they have been of all degrees, from Proudhon's celebrated *mot* that "all property is theft," to George's eloquent plea that the cause of poverty is private ownership of land; but *mots* are not proofs and eloquence is not always truth. Yet there must be some other explanation for this phenomenon than is to be found in the envy and jealousy of some over the good fortune of others.

The sentiments and feelings of those who find fault with the existing economic order are in part accounted for by their disap-

pointment with the results which the invention of labor-saving machinery promised to fulfill. "It was expected that labor-saving inventions would lighten the toil and improve the condition of the laborer; that the enormous increase in the power of producing wealth would make real poverty a thing of the past."* For the first time in the history of the world the niggardliness of Nature seemed to have been overcome, and it appeared possible for man to produce enough to satisfy all his wants. The cry of "overproduction," now so generally heard, lends some color to this view. Yet it is susceptible of mathematical proof that if the whole production of the civilized world could be distributed equally among all the inhabitants thereof, it would not raise any of them to affluence or rid them of the necessity of close economy and of hard, continuous labor. This disappointment with Nature does not, however, wholly account for existing sentiment in regard to the distribution of wealth. There is still a residuum to be explained.

The fundamental principle upon which social intercourse rests is that of equal freedom, or the right of "every man to do all that he wills, provided he infringes not the equal freedom of any other man."† Certain conditions are necessary to social well-being, and this equality of freedom is essential, so that men's characters may be wrought into harmony with these necessary conditions. It is upon this right to equal freedom that the right to property rests: indeed, the two rights are regarded as synonymous. "The legitimacy of private property has, since the time of Locke, been based by the greater number of political economists on the right inherent in every workman either to consume or to save the product of his labor,"‡ that is to say, on the freedom to do as he wills with his own, provided he does not infringe upon the equal right of others to do the same. Furthermore, it is a logical deduction from the principle of freedom that every man is entitled to claim as his own the fruits of his labor and his savings, for this principle requires not that all shall share alike, but that each shall have like freedom to pursue and acquire the object of his desires.

Beyond the restraints which the law of equal freedom itself imposes, there are other secondary restraints which are necessary to right living. Men may in a variety of ways make themselves obnoxious to their fellows without breaking the law of equal freedom; hence the necessity of both negative and positive beneficence as supplementary principles to regulate human nature. These, however, belong to the sphere of ethics proper, and not to that part of it we are considering.

It seems to be an inevitable conclusion that, subject only to

* "Progress and Poverty," Henry George, p. 3.

† "Social Statics," Herbert Spencer, p. 121.

‡ Roscher's "Political Economy," vol. I, p. 235.

the limitations just mentioned, we are entitled to do what we please with our own, and this also seems to be in accord with the principles of justice, of which, indeed, the law of equal freedom is the embodiment. But does this cover the whole extent of our obligation? Every right has for its correlative a duty to be performed. Are all such duties included in the limitations upon rights that have been mentioned? Has society no just claims upon its members other than those of mutual forbearance? Clearly not, for rights are not the measure of duties. The latter occupy a much larger field of life, and, although their consideration is chiefly confined to ethics proper, yet in the study of economics a clearer recognition of social duties and an insistance upon their needfulness as factors in securing the greatest economic return for efforts expended will tend to put the science upon a surer foundation. Take, for instance, the great question of *laissez-faire*. As Prof. Sidgwick says: "We can not determine what government ought to do without considering what private persons may be expected to do; and what they may be expected to do will, to some extent at least, depend on what it is thought to be their duty to do; and, more generally, it was before observed that in the performance even of the ordinary industrial functions with which economic science is primarily concerned, men are not merely influenced by the motive of self-interest, as economists have sometimes assumed, but also extensively by moral considerations."*

We have here reached also an explanation of the residuum of existing sentiment in regard to the distribution of wealth. The duties which its creation imposes upon all the men who produce it are not distinctly realized by the mass of mankind. On the contrary, individuals and classes are more often concerned with their own rights and the duties of others. Dissatisfaction naturally follows, as we are sure to find fault with others for the non-performance of duty, while forgetting that our own neglect must produce the same dissatisfaction elsewhere. This applies as well to the laborer as the employer or capitalist. All owe it to society that they shall exercise their economic functions in such a manner as to enhance the social well-being. For, "it should not be forgotten here that, at least in the higher stages of the economy of nations, scarcely any work or saving is possible without the co-operation of society. And society must be conceived not only as the sum total of the now living individuals that compose it, but in its entire past, present, and future, and also as being led and borne onward by eternal ideas and wants."†

This is not the only economic service which society renders to

* "Principles of Political Economy," p. 583.

† Roscher's "Political Economy," vol. i, pp. 235, 236.

mankind. In addition to the security which it gives to labor and to property, it increases their value as well. "Social growth creates a demand for a constantly increasing quantity of every sort of staple goods. The greater the quantity demanded and sold, the less is the cost of production per unit of product. Not that the mere multiplication of human beings is itself creative of wealth, but that the multiplication of utilities by the productive labor of additional human beings enhances the utility created by each one. It does this by creating the means for more perfectly utilizing all labor and all means of production."*

Let us now apply the principle of social duty and the test of social well-being to some of the economic questions of the day. Does our social duty, or the social welfare, require of us that we shall surrender the right of private property, either in whole or in part, as demanded by the communist and socialist? We have already indicated some of the advantages which result to society from the individualistic idea of property. It now remains to point out the disadvantages which would be likely to follow from the adoption of the communistic or socialistic ideal. The first proposes to organize society "so as to distribute the annual produce of the labor and capital of the community either in equal shares or in shares varying not according to the deserts but according to the needs of the recipient."†

The decisive objection to this theory is, that it violates the first principles of justice, in that it proposes to distribute rewards, not in accordance with efforts expended, but in accordance to need, no matter how that need was occasioned, whether through the fault or the misfortune of the recipient. The unequal results that are caused by equal freedom may be deplored and voluntarily alleviated; but it would neither be wise nor well forcibly to prevent these results by taking away from the more fortunate, and thus preventing the natural penalty to be visited upon the slothful and the idle. The inevitable result of such a policy would be to decrease the amount to be divided by removing the normal stimulus to industrial activity, and preventing the normal check upon laziness.

So far as socialism involves a similar theory, the same objections may be urged against it, but this word is generally used to cover the proposition of substituting the governmental for private and competitive management. Now, it is the testimony of nearly every competent observer that governmental management is less economical, less energetic, and less plastic than private management. The result of its substitution would be in the long run to lower the product both in quality and quantity, through

* Franklin H. Giddings, in the "Quarterly Journal of Economics," April, 1887, p. 371.

† Sidgwick, "Political Economy," p. 526.

waste, incompetence, and a tendency to retain old methods where new and better ones should be tried. The reasons for this are not far to seek. Lacking the normal and powerful stimulus of self-interest, as well as the energy which is the outgrowth of competition, the state, as an industrial agent, can never be relied upon to equal in productive results the present system of individual management. But this of itself would not necessarily condemn it, if it can be shown that socialism, by raising the moral tone of society and more equitably distributing its economic product, gets rid of those evils which, it is claimed, are caused by individualism, and, thus elevating the standard of social well-being, more than balances the loss in production. It is indeed conceivable that men might live happier and better than they do at present by restoring the ancient ideal, and limiting their wants to those things only which are essential to human welfare; and that production might, as a whole, be less than it now is, and yet society be better off, if work were so guided that there should be no such thing as overproduction of some articles and underproduction of others; or that such a ratio should be preserved that the purchasing power of the masses would keep pace with their productive power.

To this, however, it may be replied that there is no good reason for thinking that the state will be a better judge of what is essential for human welfare than the individuals who compose it, and it would not be as sure a check upon "overproduction" as the self-interest of the individual producers; for this will keep them alert and watchful of the conditions affecting demand and supply.

Moreover, the interests of society are advanced in several ways by the unequal distribution of wealth. If all existing wealth were equally distributed, it would not raise any one to affluence, or make unnecessary hard and continuous labor. A certain amount of leisure is absolutely necessary to the cultivation of those tastes and talents upon which the general culture and special knowledge of mankind depend. It is obvious that, where men have no time to devote to such matters, in consequence of the necessity of giving all their hours of labor to the production of the essential means of existence, the higher and particularly those immaterial forms of wealth out of which many of the greatest social gratifications are obtained will either not be produced at all, or produced to only a limited extent. Hence, the general culture of the community will suffer from this lack, and a lower type of organism will be developed.

To a certain extent the cultivation of science might, in such a community, be made a means of bread-winning, as its usefulness could be made more apparent, but the pursuit of knowledge would

be likely to be confined to practical ends, and the resulting disadvantages to society would be very great. It would be impossible to calculate the amount of social benefit that has accrued from the unremunerated intellectual activity of men who have devoted their lives to the pursuit of knowledge for its own sake. Much of this devotion has been made possible by the existence of rich men who have directly or indirectly furnished the means to this end. Many of our schools, colleges, libraries, and art-galleries have been founded or more or less supported by contributions from the rich, and a deeper and richer economic return has been made possible.

But the fundamental objection to socialism is, that the economical disadvantages which its adoption would surely entail would not be balanced by ethical benefits that would repay the loss. The evils of which socialists chiefly complain are due to the inherent defects of human nature as it is. While some of these defects may be increased and intensified by the system of private property and free competition that now obtains, it is altogether unlikely that a change in the system would of itself greatly modify human nature. That requires long time and a co-operation of all the social factors. Moreover, the growth of the sense of social obligation gives promise that these very defects may be lessened and eventually overcome, by a more thorough recognition of our social duties and responsibilities, and the cultivation of a public opinion that will insist upon their performance. The main "justification of the existing industrial system is that it secures more responsible and far-sighted management of capital than could be obtained in any other way"; but when we "attempt to enjoy the rights of property without corresponding responsibilities," we give our opponents their most powerful weapon.*

As a first requisite to the establishment of a correct public opinion, it is needful that we should teach more broadly the truth that men have no absolute right to do as they please with their own, and that the obligations which contract imposes are not the only ones to be taken into consideration. Not only must we, in accordance with the law of equal freedom, forbear to interfere with the equal rights of others, but we must also remember that our duty calls upon us to use our rights in such a way as not to demoralize, but on the contrary to conserve, the community in which we live. The test of this is the principle with which we set out—the well-being of society. We may not always be able to decide positively as to what is best in every case for the social welfare, but it is possible for us to do so in many instances; and wherever the absolute exercise of any right, which the principles of political economy otherwise sanction, seems likely to be detri-

* "The Nation" for December 1, 1887, p. 431.

mental to society, it is our duty to point out the limitations of this right, and to do so with the greater insistence, because the natural propensities of man will generally lead him to choose immediate rather than remote advantages, although the latter always coincide with the well-being of society. In other words, morality becomes the basis of our economics; for it is the "cardinal trait of the self-restraint called moral" that it is made up of those representative and re-representative feelings which, becoming increasingly ideal, enable us to postpone immediate for future gratification.*

The basis of the old political economy was self-interest; its fundamental assumption, that "men strive to obtain the maximum of satisfaction with the minimum of sacrifice"; and the creature that it studied was the "economic man." There was much of truth in all this, but not the whole truth. Our ethical economics adds to self-interest the social interest, and the being whom it studies, "the starting-point as well as the object-point of our science, is man" † as he is, with all those thoughts and feelings, those longings, desires, and wants, both of the body and the mind, which are a product of the social factor.

The history of our economic thought and economic action is a further proof of this. There seems always to have been a tendency to the establishment of a moving equilibrium between those forces which make for individualism and those forces which make for socialism, and an extreme development in one direction brings more strongly into play the opposite tendency. Individualism has just had its day; socialism seems now to be coming to the front, but, if not curbed before it has gone too far, the pendulum will again swing toward unappeasable individualism. Happily, however, for man, he is more susceptible of change in the direction of his nobler impulses and toward an ever-growing sense of justice and duty; and, wherever sympathy does not conspire to produce this result, it is eventually brought about by self-interest. Whenever the public opinion of any community allows men to "enforce their rights with hands of iron, while they disclaim their duties with fronts of brass," a reaction is sure to occur sooner or later, and, in order to preserve and retain some of the rights which this reaction imperils, greater concessions must be made to the opposing sentiment. These concessions, once obtained, become the starting-point for new rights and duties, and when these are found to be useful to society they are preserved. A new adjustment is inaugurated, but this time upon a higher moral plane than the former. Thus, "at the suggestion of some immediate interest or convenience," or through the impulse of the higher moral feelings

* See Spencer's "Data of Ethics," chap. vii.

† Roscher's "Political Economy," vol. i, p. 51.

which have already been brought about as described, "fresh types of conduct gradually set into form and give rise to corresponding rules. These rules are the body of morals."* Nor is this all. As this conduct becomes habitual in the individual it affects him physiologically as well as psychologically, and through the changed cerebral structure which it produces, it is transmitted to his offspring, to become in the long process of the ages those moral intuitions which we group under the name of conscience. Note further that the kinds of conduct which our intuitions regard as authoritatively prescribed are such as long social contact has shown to be essential to the well-being of society, and that this same well-being furnishes us the test of our duty to fulfill obligations which for any reason have become ambiguous and indefinite. May we not conclude, then, that the fulfillment of duty to self and to society is the true end of economic action? If so, "let us bind love with duty, for duty is the love of law, and law is the nature of the Eternal" †

CURIOSITIES OF EVOLUTION.

By Mrs. ALICE BODINGTON.

NOTHING is more strange in the history of evolution than the persistence of rudimentary structures, which have lost all usefulness untold generations ago, and in many cases have become absolutely dangerous to the organism. Among these survivals, one of the most curious is the pisiform bone of the wrist, which careful researches in comparative anatomy show to be the carpal or wrist bone belonging to a long-vanished sixth finger. The oldest mammals discovered have never more than five fingers. It is necessary to go back to amphibian forms to find a sixth finger, yet all mammals possess the wrist-bone formerly belonging to it. The pineal gland, once supposed, for want of a better hypothesis, to be the seat of the soul, is a still more curious instance of survival, inherited probably from some transparent invertebrate ancestor with a median eye.

In mammals the pineal gland is deeply sunk beneath the highly developed intellectual portion of the brain, in a position utterly cut off from all possible communication with the outer world. Human physiology alone would have left us utterly without a clew as to the original use of this mysterious body. The secret was discovered after long and patient study of the brains of amphibians and reptiles. In these animals the intellectual portion of the brain (cerebrum) is in a very undeveloped condition, and

* Martineau, "Types of Ethical Theory," vol. ii, p. 374.

† "Daniel Deronda," George Eliot, vol. ii, p. 335.

the pineal gland is not covered. It lies just beneath the parietal suture, that portion of the top of the skull where the bones are still ununited in new-born children. In many reptiles, notably *Hatteria* (Fig. 1) and *Aurelia*, the pineal gland is found to be an optic lobe, united to the nerve-stalk of a true eye, richly supplied with a branched blood-vessel and nerve. Although this eye still possesses every essential part of a visual organ, yet degenerative changes have set in, which show that it has been long useless. In *Varanus giganteus* (Fig. 2), where a scale on the top of the head is fitted by its transparency and whiteness to act as a cornea, a large mass of pigment has accumulated just beneath, effectually preventing the possibility of any rays of light reaching the retina. In *Hatteria*, the eye appears fitted in all respects for vision, but a thick band of connective tissue has formed above it, and there is no modified scale. In both animals, *Hatteria* and *Varanus*, the rods and cones of the retina are strangely elongated in certain parts, as though from straining to catch the last rays of vanishing light. The rods of this portion are at least three times the length of the ordinary ones, and are in connection with a special group of nucleated cells.

In modern amphibians the greatly degenerated eye is separated entirely from the pineal stalk, though a connection still exists during embryonic life. But there is reason to think that among ancient amphibians—more especially among the labyrinthodonts—the pineal eye reached its very highest development, since it is found *outside* the skull. A large parietal opening, with roughnesses of the skull-bones serving as attachments for powerful muscles, is found in the great extinct amphibians and reptiles. The pineal eye was pre-eminently a sense-organ of pre-tertiary periods; it has probably never been functional since these remote ages, and yet its rudiments persist in every human brain. Moreover, these eyes are of the *invertebrate* type, pointing back to that conjectural molluscoid ancestor which was "transparent and had a median eye."

The records of pathology teem with instances of rudimentary organs which have lost their use and have become sources of danger and disease. I venture to think these facts are far too little known to those outside of the medical profession who are interested in evolution. It is not necessary to do more than allude to the "appendix vermiformis," since every reader of the "Descent of Man" will remember it as the typical instance of a mischievous rudimentary organ, given by Darwin.

All mammals possess, during their embryonic life, three sets of kidneys. The first set of tubules cease very early in fetal life to act as kidneys; they take on a new function of supreme importance, their ducts becoming the oviducts in most fishes, amphibians, rep-

tiles, and birds, and constituting the uterus and Fallopian tubes in mammals. In their earliest stage they are known as the *pronephros*, or "head-kidney," and answer to the permanent condition of the renal organs in worms; in their second stage they are known as the "ducts of Müller."

The second set of tubules constitute the *mesonephros* or Wolffian bodies; they act for a time as kidneys, and then become

FIG. 1.—PINEAL EYE IN *Hatteria*. A, nerve; B, blood-vessel; C, retina; D, greatly elongated rods and cones of retina.

the ducts of the generative organs in the male. In the female they have no later functions, but their atrophied remains persist, and give rise to various forms of cystic disease. The upper division of the Wolffian duct, with its tubes, can be found lying above the ovaries, and is known as the *parovarium*. It is frequently the seat of degenerative disease, not only in human beings, but in lionesses, tigresses, and cows. The middle portion often disappears, but in the cow the whole tube persists, useless always, and mischievous very frequently. Both sets of tubules, those of the pronephros and those of the mesonephros, or, in other words, the ducts of Müller and the Wolffian ducts, persist throughout life in both males and females, one set becoming

highly developed, and the other atrophying, according to sex. This fact, of course, points back conclusively to primitive ancestors of fishes, reptiles, birds, and mammals, which were hermaphrodite. The argument for design is utterly put out of court by the awkwardness of the whole plan, and the disease and suffering caused in mammalian females by the ovaries having no

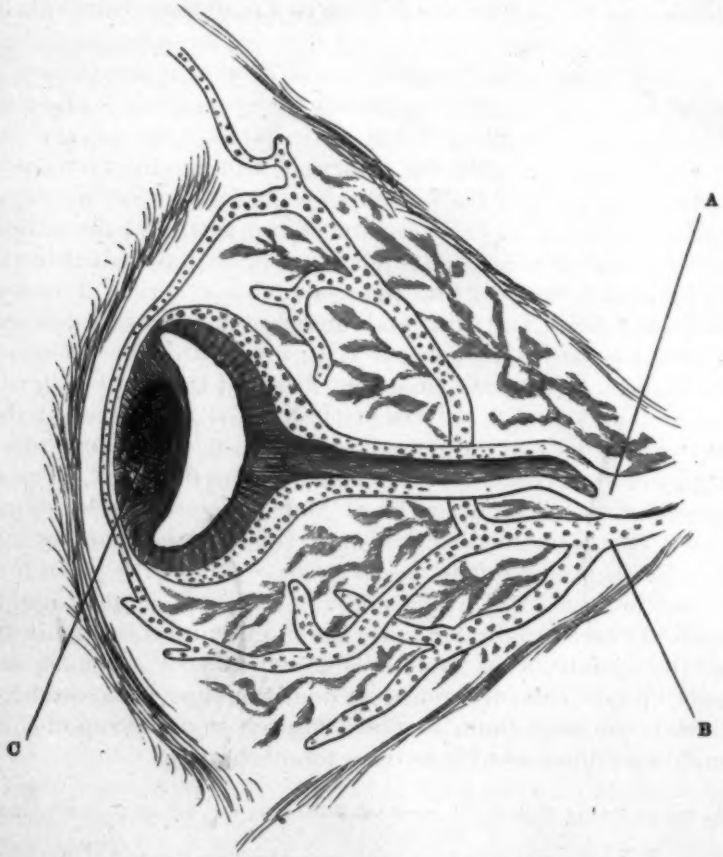

FIG. 2.—PINEAL EYE IN *Varanus giganteus*. A, nerve divided into three branches; B, blood-vessel branching and going round the eye; C, mass of pigment.

original connection with the uterus and by the survival of useless rudimentary organs. As a blind effort of Nature in the process of converting a hermaphrodite worm into a warm blooded mammal, the process has its wonderful and admirable side. The third set of kidneys are, of course, the permanent ones.

Prof. Cope, in his "Origin of the Fittest," draws attention to what he names the "law of acceleration and retardation." This law, though it may indirectly lead to the "survival of the fittest," is equally likely, through its blind action, to lead to the extinction of an animal which had once been the "fittest" in its

relation to the environment. There can be little doubt that the enormous tusks of the early elephants and the formidable canines of many early carnivores would enable them at first to distance all competitors. But the law of acceleration tended blindly always in the same direction, till the old elephants seem to have been weighed down by their extravagant tusks, and the most highly specialized of all carnivores had canines so long that they could not shut their mouths, and both speedily became extinct. The law of retardation exhibits itself in the teeth of the higher races of mankind in a highly inconvenient manner. The greatly developed brain requires all the available room in the skull; there is no space left for the attachment of muscles for a powerful jaw. Cooked food also causes a degeneracy in the development of the jaw. There is constantly no room left for either the wisdom-teeth or the second upper incisors; the wisdom-teeth are retarded, often cause great pain, and decay early. The second incisors appear in startling and unexpected places, and often (in America especially) do not cut the gum at all. Prof. Cope says that "American dentists have observed that the third molar teeth (wisdom-teeth) are in natives of the United States very liable to imperfect growth or suppression, and to a degree entirely unknown among savage or even many civilized races." The same suppression has been observed in the *outer pair of superior incisors*. This is owing not only to a reduction in the size of the arches of the jaws, but to *successively prolonged delay in the appearance of the teeth*. In the same way men, and the man-like apes, have fewer teeth than the lower monkeys, and these again fewer than the insectivorous mammals to which they are most nearly allied. When this difference in dentition has been established, civilized man may claim to place himself in a new species, apart from low savages as well as from the high apes.

SPIDERS AND THEIR WAYS.

By M. ÉMILE BLANCHARD,
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SPIDERS live in both hemispheres—from the torrid zone to the coldest regions. Over all the world they are distinguished by their singular aspects and curious habits. The largest and gayest-colored species are found in the tropics. In cold and temperate latitudes live smaller species and more tamely colored, which attract attention by other titles than that of their garb.

As classified by naturalists, the spiders compose an order of the class of *Arachnida*. They are the *Araneids*, a division so well characterized and perfectly circumscribed that it is suffi-

ciently designated when it is named. In these animals the head and corselet are confounded into a single mass, at the upper part of which is a kind of dorsal buckler, supporting in front the organs of vision. The eyes are generally eight in number, but are variously grouped, according to the types. Walckenaër, at the beginning of this century, made the disposition of the eyes a criterion of distinction between the genera and species. More recently, some remarkable coincidences having been noticed between the disposition of the eyes and the habits of the species, it became recognized that that feature could be relied upon in an animal wholly a stranger to determine the conditions of its existence and the way it got its living. The eyes do not turn in their socket like man's, for the cornea is only a tegumentary part which remains transparent. This immobility is an imperfection which is amply compensated for by the different orientations of the numerous organs, and their dispersion and grouping in such a manner as to respond to all the visual necessities of the animal. Being silent animals, and never having to answer to a call, spiders are backward in distinguishing sounds. This fact is assured by some features in their conformation. The romances that have been woven about their fondness for music are purely illusory. The disturbances which they experience at the playing of violins and pianos are simply effects of the vibration of their webs. Alarmed by it, they quit their hiding-places and run about in panic.

Beneath the front of the spider project two thick processes armed with a movable hook—the antennæ forceps—which conceal a poison-gland with a little tube running out to near the point of the hook. All who have seen a spider taking a fly have remarked how it stings its victim so as to kill it before introducing it to its mouth. At the edge of the buccal orifice of those species that live on fluids, exist only a simple tongue and two highly developed palpi behind it.

Spiders are differentiated from insects, which have six legs, by having four pairs of legs (Fig. 1). These members support hooks at their ends, which are working instruments of astonishing perfection. The body and limbs are covered with hair, fine down, and spines. These are the organs of touch, often of exquisite sensitiveness, planted in the skin. Under the microscope the downy hairs, which are hardly visible to the naked eye, appear fringed and bearded like incomparably delicate feathers. When we consider the habitual neatness of their clothing, to which grains of dust would so readily stick, we are satisfied that spiders are far from the hindmost in the care they give to their toilet. Their long, hooked legs perform an office that leaves nothing to be desired. At the extremity of the body may be found mobile articulated

tubes, having solid walls, and the end truncated with a membranous surface, riddled with holes. By these microscopic openings escapes the liquid which, hardened in contact with the air, becomes the thread out of which the web and the cocoon are made. Although it is cited as the type of fineness, this thread is formed of several fibers, which adhere together on issuing from the spinneret. It is unrivaled for evenness, delicacy, and power of resistance.

The internal organization of the spider is even more admirable than the external parts. It would be hardly possible even to point out in this paper the most essential features of it. It would be going into long details to describe a muscular apparatus having a power of which the animal kingdom affords few examples, assuring wonderful precision and agility in movement; a nervous system whose enormous development accounts for faculties of a superior order; and a stomach of construction peculiarly adapted to a diet composed exclusively of fluids. It is written that spiders breathe by lungs. They have an aërial respiration, but it is by organs very different in structure from the lungs of man. They consist of minute pockets containing flattened sacks packed like the leaves of a book, through the walls of which the blood infiltrates, and the interior of which is penetrated by the air. Thus observed under water, the little sacks appear like so many sheets of silver communicating with the outside by slits at the bottom of the belly. Spiders have also a heart and a circulation of blood of the most complex character. The heart, which is on the dorsal face, is of an ideal anatomical structure, and long evaded the attempts of investigators to discover the vessels that carry the blood to the periphery of the body. The main vessels were finally traced out by means of colored injections in the European species, and the smaller ones afterward in the larger South American species. The study was a most charming one to

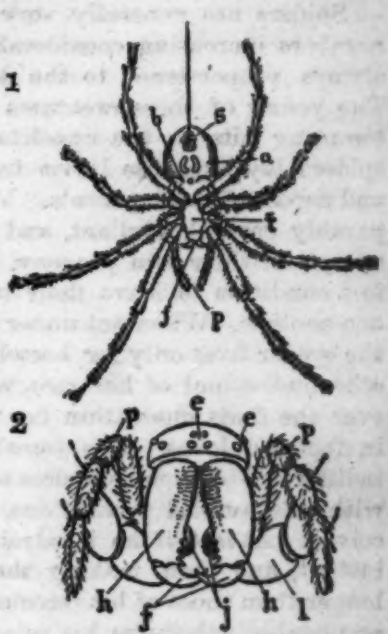

FIG. 1.—PARTS OF A SPIDER.

1. Under part of a spider's body—*t*, the thorax or chest, from which the eight legs spring, and to which the head is united in one piece; *f*, fangs; *p*, palpi or feelers attached to the jaws; *a*, abdomen; *b*, breathing slits; *s*, six spinnerets, with thread coming from them.
2. Front of spider's head—*e*, eyes; *p*, palpi; *l*, front legs; *h*, hasp of fangs; *f*, poison fangs; *j*, outer jaws.

the young naturalist who made it about forty years ago, revealing a beautiful force-pump action, executed by instruments of infinite delicacy, and a power with which no machine of human invention can be compared.

Spiders are generally very prolific; yet we never see their numbers increasing considerably in any country. Fecundity is always proportioned to the dangers that threaten individuals. The young of these creatures so skilled in spreading nets are tempting bits to the appetites of carnivorous birds. All the spiders lay eggs, the larvæ from which have already the form and aspect of their parents. While as mothers they are incomparably careful, vigilant, and devoted, spiders show no feeling except for their own progeny. From the moment the young are in a condition to leave their mother, they become isolated from one another. When not under the influence of maternal instincts, the spider lives only for herself, ignoring the existence of every other individual of her race, which she devours pitilessly whenever she finds one within her reach. In such a world there are, in fact, no loves. The females are believed to be absolutely indifferent. If a male desires to contract a marriage, he proceeds with unexampled precautions, as if he knew he would be ill received. At last, if he is adroit, he will enjoy an embrace of an instant, and then, making the best use of his legs, which are longer than those of his ferocious spouse, he gets away as quickly as possible, otherwise his relative weakness would make him a victim. Poor male spider! He can not know the joys of paternity, but he can doubtless renew again and again his short instants of pleasure, for the two sexes are represented in the most unequal manner, the females being ten or twenty times as numerous as the males. The facts just related apply to spiders in general. But the various types furnish examples of special industries, aptitudes, and manners, on account of which it is necessary to divide our subject into special histories.

On the edge of the forest, among the rough-barked trees, or in dilapidated walls in the open fields, one may see in hot, sunshiny days numerous little spiders, scattered singly or gathered in groups, among which no hostility is manifested. Parts of their bodies are sometimes glossy and brightly colored, sometimes adorned with regular and elegant designs, forming a fine white, yellow, or red pubescence. They are extremely lively, and seek the brightest light. If the amateur tries to catch one he will be disappointed, for it will escape him and get out of the way at a bound. These spiders, jumpers, belong to the group which naturalists call the saltatory spiders (Fig. 2). Some of them are disguised, as if for protective resemblance, with the costume of a hymenopterous insect, or under an aspect resembling that of ants. Producing

only a small quantity of silk, they hide themselves in cracks in the walls or in fissures of bark in the shadow of the foliage, and make themselves a lodge out of a smooth or flossy tissue. At the laying of its eggs, the jumper shuts itself up in its shell. One species deposits its eggs without any covering; a more fortunate species incloses them in a sack with thin and almost diaphanous walls. Not having the faculty of spinning webs, the saltatory spiders are hunters, and have to fast if the weather is bad. On pleasant days they are to be found all around, and, having eyes all over the cephalic region, some of them quite small and others of enormous size, they can look accurately through all the surrounding space, which they explore slowly and with care. If a fly is in sight, the spider lances itself upon it with dizzy rapidity. It measures its distance so well that it rarely misses; but, if this should happen, no harm comes to it, for it has fixed a thread to its starting-point, which, unrolling as it leaps, prevents its striking upon the ground, and affords an easy road back to its position.

FIG. 2.—JUMPING SPIDER (*Attus familiaris*).

Some spiders are wealthy, having at their disposal an immense quantity of textile matter, which is renewed continually; others produce but little, and have to live in cells under stones or dead

FIG. 3.—WOLF SPIDER (*Lycosa fortifera*).

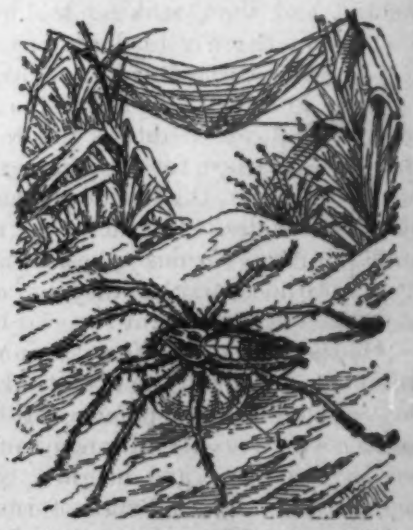

FIG. 4.—HUNTING SPIDER (*Dolomedes mirabilis*), with a bag of eggs, *b*.

leaves, in the cracks of trees, and in walls. They have to hunt their game in the fields, along the edges of the water, or among aquatic plants. They are the *Lycosæ* (Fig. 3). The smaller, dark-colored species of central Europe have little to attract the eye; but occasionally the attention of the careful observer is directed

to one which is running rapidly along the road or trying to hide itself in the grass. It is carrying a pure white, round shell—the sack containing the eggs—in making which it has expended all the silk it had (Fig. 4). A mother of incomparable vigilance, homeless, its eggs laid and well protected in the silky walls of the shell, it does not abandon the cradle of its offspring for an instant. If we succeed in seizing one of the animals during its journey and take away its cocoon, the spider, usually so timid, instead of running away, makes a show of fight against the aggressor. If the cocoon is on the ground, it makes most earnest efforts to take it up and run away as quickly as possible. As soon as the young are hatched they attach themselves to the body of their mother, and she carries them till they are strong enough to hunt a prey, crafty enough to deceive an enemy, and ungrateful enough to cease to recognize a mother whose care has become of no use to them. Large lycosas adorned with lively colors inhabit southern Europe, Africa, and some parts of Asia. They are wanderers like their congeners of cold and temperate countries, and have the advantage over them of a longer existence and of having fixed retreats. They dig a cell in the ground, tapestry its walls, and weave a barricade of crossed threads across the entrance. Among them is the tarantula, concerning the effect of whose bite many marvelous but fictitious stories are told.

The smaller rivers of Europe are inhabited by an aquatic spider, the *Argyronetus aquaticus*, the first observation of which was a considerable surprise to the Père de Lignac, who discovered it and first described it. It was in 1747, and he was bathing in a river near Mans, when, he relates, "I was surprised by a wonderful sight: bubbles of air, bright as polished silver, appeared to swim around me and follow me. Their free movements, which were not determined by the motion of the water or by the levity of the air, declared that they were animated. My surprise shortly became astonishment when I perceived that they were large spiders whose bodies were enveloped in air." Two years afterward, Lignac obtained several specimens of the argyronetus, and made a closer study of them. While their nearly constant abode is the water, they are, like most other spiders, air-breathers; consequently they need some special provision for providing themselves with air while living under the water, and for this purpose they possess the art of constructing a kind of diving-bell. It is an interesting sight to witness one of them making his air-cell. Clinging to the lower side of a few leaves, and securing them in position by spinning a few threads, the spider rises to the level of the water, with its belly uppermost, and, doubling up its hind-legs, retains a stratum of air among the hairs with which its body is covered. Then it plunges into the water and appears as in the

first stage of the making of its silvery robe. Going immediately to the spot it had chosen, it brushes its body with its paws, when the air detaches itself and forms a bubble under the leaf. The

FIG. 5.—AQUATIC SPIDER AND ITS DIVING-BELL.

spider surrounds this bubble with the impermeable silky matter furnished by its spinneret. Returning to the surface, it takes in another layer of air, which it carries down and adds to the first

one, also extending the envelope over it. The process is kept up till the "diving-bell" has reached the proper size, and is finished. The ideal form of the construction is that of a thimble, but it often assumes an irregular shape, like an inverted sack (Fig. 5). When the spider has taken possession of its redoubt it remains quiet in it, head down, watching for the appearance of an insect. Perceiving one, it seizes it and returns to its lodge, which it has secured against intruders by spinning threads across it, to devour its prey at its leisure. The argyroneti being as ferocious as other spiders, the matter of marriage involves a grave crisis to the male. If he should present himself bluntly at the female's diving-bell, the result of the application would probably be fatal to him. But his instincts are adequate to the occasion, and he uses diplomacy, stratagem, and address. He makes a diving-bell near the female's, and adds a wide gallery between them. When his preliminary operations have been finished, he breaks through the wall of the female's lodge and surprises her into an embrace which is not always disagreeable to her. The young live for some time with their mother, whose solicitude for her little family is unremitting. When they have become strong enough, the young ones accept the struggle for existence and separate, each one going, as its parents did, to construct its cell and live a solitary life.

We now change our point of observation, and look at a spider that lives still another kind of life—as an inhabitant of our homes (Fig. 6). In a corner of the room under the ceiling is stretched a web, and on the web, watchful, stands a long-legged spider. It is the spider of all dwellings, and its presence is tolerated—the *Tegenaria domestica*. It has so pronounced a taste for dwelling-houses that it acts as if men's houses were built especially for it. A skillful weaver, it has at its disposal a quite abundant mass of silk. Its web is formed of an even material, which has been carded by tools of exquisite fineness, assuring the perfection of the work. When new, the web is a pure white; but it soon becomes soiled with dust and wears an unpleasant look, which, however, does not seem to give the proprietor any concern. The domestic spider is timid, and does not feel fully secure unless it has a good hiding-place to run to. It has reserved a vacant spot in the corner of the wall, and this is the road by which it steals away when it is alarmed. Beneath its web it has fixed a roomy hammock in which to take refuge. It deposits its eggs in a silken cocoon, which it hides under foreign bodies to conceal it from the greed of animals that would appreciate too well the delicious meats. During incubation, the

FIG. 6.—COMMON HOUSE SPIDER (*Tegenaria medicinalis.*)

mother watches the cocoon unceasingly, even forgetting to feed herself. When the young have escaped from their cradle, the starved mother returns to her web, where she sits and devours flies so numerously that the ground beneath becomes littered with their bodies. The domestic spider rarely inhabits the holes in rocks and the hollows of old trees, which are preferred by so many other creatures. Open-air species of the south and center of Europe, where the temperature is never rigorous, learn in the cold climates of the north, as in Scandinavia, to insinuate themselves into the houses—wise animals, that seem to know they will require a shelter from the cold.

We inhabitants of houses need not be above sharing our life with spiders. The part they perform is appreciated in the country, where they are not destroyed or disturbed in bedrooms or stables. The flies are a perpetual cause of torment to the people and to animals, and they perish in the webs of spiders, with perceptible decrease in their numbers. Spiders are, indeed, valuable servants given us by Nature.

On clear and sunny days, especially in the latter part of the summer, when a light breeze is blowing, long threads and flakes of a snowy whiteness may be seen floating in the air; or, covering the grass of the flowery meadows, they wave in the breeze and cause on the lawns shimmerings of strange effect. The peasantry of France call them the Virgin's threads. More accurately the naturalist would say they are the threads, abandoned as if to chance, of a kind of spider very common in the fields, which is called the gossamer spider. These spiders are wanderers, and frequent low plants and shrubs; small in size and loving the bright light, they wear lively colors which often confound them with the flowers and mask them from the pursuit of carnivorous animals. Their motions are abrupt and rapid, and their broad bellies give them a singular gait, something like that of crabs that we see running over the sea-beaches. They do not spin webs, but watch for passing insects, and, precipitating themselves upon their game with a sudden spring and extraordinary address, they rarely fail to secure it. The gossamer spider takes shelter under stones or plants or in holes. At the breeding-season they construct a sack to hold their eggs, and from that moment become sedentary and abstinent, watching over their posterity.

As day butterflies are gayer than night-moths, so do the epeïras show to better advantage than other spiders. They have for the most part either handsome colors or agreeable shades, and they hold the supreme rank as spinners. The European representatives of the group are modest in appearance, but in tropical countries the species to large size add luxury in dress. They are numerous enough on the globe to form a large family, that of the *Epeïridæ*,

which is composed of many genera (Fig. 7); but the family is one of which the members are all so alike that they all bear the same general signs and pursue the same kind of industry. The epeïras weave webs of enormous proportions, with large, regular meshes. As they work in broad daylight, among the most beautiful features of nature, it is possible to follow them in all their operations, which are performed as if expressly to charm a philosopher. The spectacle may be witnessed every summer in the parks and gardens of Paris in the webs of the *Epeïra diadema*, which sometimes obstruct the streets. This spider is of a reddish-yellow color, marked on the upper part in dark hues with a figure that has been compared with the cross of St. Denis. Posted on a branch of privet, lilac, or cytissus, it puts forth a thread of silk which lengthens out under the very eye of the observer, and, caught up by the lightest breath of air, at last fastens itself to the limb of a shrub, often at a considerable distance from the point of departure. Subsequently the spinner herself mounts the aërial cord, and fastens it to the place where it has fixed itself, adjusting its position if necessary. The most skilled balancers in the circus would lose in the comparison with the epeïra of the gardens, which manœuvres in every kind of attitude, upon a thread of extreme tenuity, with an ease and agility that defy all parallel. Threads carried to new points of support among the branches are adjusted so as to form a polygonal framework. This done, the spider returns upon the bridge which it first threw over, and stopping exactly in the middle, as if it had calculated the spot geometrically, it drops, head down, hanging to a thread which would divide the polygon in two. At the central point is fixed a fleck of silk that serves as a support to all the rays which diverge regularly to the periphery. The frame is made, but a final operation remains to be completed. An agglutinating thread must be stuck upon the rays, so as to form a spiral. The epeïra comes to the center of the web, draws the thread, which it attaches to the fleck of silk, and passes from ray to ray, describing circles away out to the exterior line of the frame. It will finish its work by returning from the circumference to the center, to interpose new circles between the former ones. It is impossible to realize a more sagacious combination to obtain a charming network, a lace of more admirable perfection (Fig. 8). Accidents will happen to the web of the epeïra. Gusts of wind during storms, or the stroke of a bird's wing, may mar its usefulness. The skillful spinner is only slightly affected by a disaster of the kind, for in less than an hour it will construct a new network. It is in cases where the web has suffered a single tear that

FIG. 7.—COMMON EPEÏRA (*Epeïra vulgaris*).

it displays the resources of its intelligence; it makes the repairs that are called for in a way that will command the attention of the intelligent observer. Particular tools are necessary for executing works demanding precision. Accordingly, the claws of the epeïra are of a much more complicated construction than those of

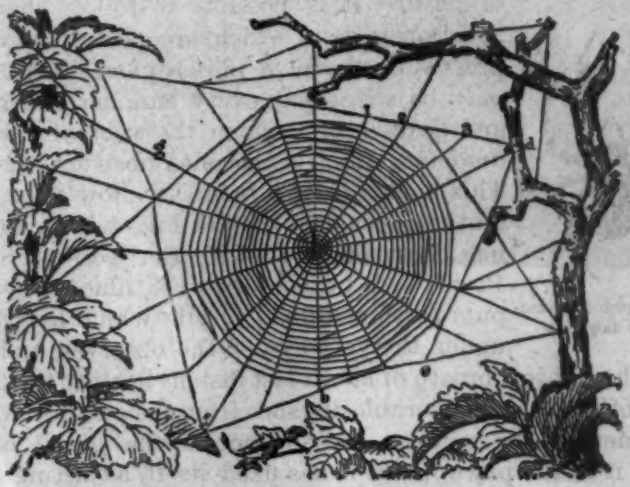

Fig. 8.—Web of the Garden Spider.

other spiders. One of them is cleft so as to form a fork, with which the artist is able to hold its threads and put them precisely where they are wanted to be.

In attack, the epeïra holds itself in the center of the web, head down. If an insect strikes against the network, it precipitates itself upon the game, which instantly finds itself held and tied in such a way that it can not escape. At the end of the summer this garden-spinner is depositing its eggs, and incloses them in a cocoon made of a different kind of silk from those which enter into the construction of its web. The poor mother, who must die in the autumn, takes care to hide the cradle of her offspring in as secluded a place as possible. The young spiders, when hatched in the spring, remain together for several weeks as one family, after which they scatter and live isolated after the general manner of the daughters of Arachne.

In various parts of the East Indies and in the islands of the Pacific Ocean there are brilliant epeïras of superb proportions. The species are numerous, and the individuals occur, in many places, in multitudes. Some of these spiders prefer situations over water-courses, where they offer the most enchanting spectacle to the eye. In the midst of the most luxuriant and intricate vegetation the epeïras stretch their nets from the tops of the highest trees from one side of the river to the other. The traveler, looking up from his canoe beneath, views with admiration these delicate

aërial structures, succeeding one another at short intervals and giving curious effects to the landscape. The great spider may generally be perceived on each of these nets, either motionless or in a state of high excitement, according as it is waiting for game or struggling with it. At some periods of the year, yellow, golden-like globes may be perceived suspended from the nets. They are the cocoons containing the eggs. In building their nets over streams, the epeïras are directed by a happy instinct. In the midst of a peculiarly bushy vegetation, they seek out broad, open spaces suitable for their establishments. In such spaces they are safest from their voracious enemies, and are at the same time conveniently situated to capture the insects that are their food. Not only are mammals and insects, lizards and birds fond of spiders, multitudes of people regard the handsome spinners as delicious meat. A large species, very abundant in the Polynesian Archipelago, is called the eatable epeïra (*Epeïra edulis*), and is much sought for by the islanders.

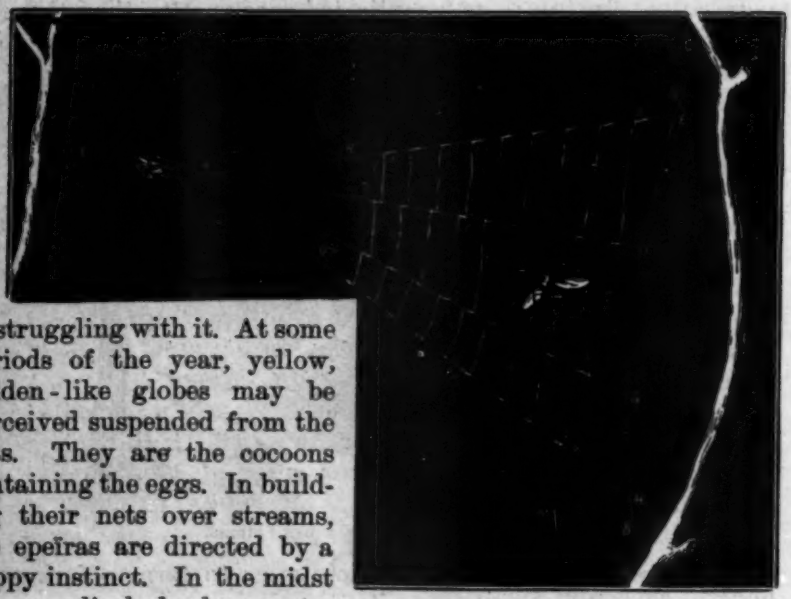

FIG. 9.—NET OF THE TRIANGLE SPIDER (*Hyptiotes Americanus*), about one half the usual length. The spider shown of the natural size.

The epeïras of Madagascar and the Mascarene Islands, according to the descriptions of Captain Dupré, are among the largest and handsomest of their kind. They build vertical webs which they attach to trees and shrubs by long threads having great power of resistance. The black epeïra predominates in the island of Réunion, the gilded epeïra in Mauritius—a magnificent animal, whose body, two inches or more in length, bears on the back a large space of bright yellow, relieved by two rows of black dots. The Madagascar species, which the Malagasy eat with relish, is yet more highly distinguished by the gayety of its dress. Its black dorsal buckler is clothed with a silvery pubescence; on its abdomen are harmoniously combined the colors of ebony, gold, and silver, and its legs are a fiery red. The disproportion in the size

of the two sexes, marked enough in all spiders, is greatly exaggerated in these two species, of which the male is a mere myrmidon by the side of the female (Fig. 11).

In the Mediterranean countries, pretty epeïras, mostly of a silvery luster, fabricate a web with regular meshes and having a singular attachment, the use of which was first discovered by M. Vinson by observing one of the species common to Mauritius and Réunion. The webs are distinguished by a single silvery thread of enormous size compared with the other threads, running across them in zigzag folds. Not having seen any use made of this cable, M. Vinson cut it several times. It was replaced in a few hours. Flies and small insects flying against the web were seized and bound without calling this thread into use. Finally, a large grasshopper was ensnared, when in an instant the spider undid the large thread and quickly bound up in it the nimble giant, against which cords strong enough to hold flies would count for nothing. This, then, was its purpose, and it is hardly possible sufficiently to admire the instinct that prompted the preparation of it.

FIG. 10.—SUPPOSED COCOON (EGG-CASE) OF THE TRIANGLE SPIDER (*Hyptiotes Americanus*). *A*, the cocoon, of natural size, hung by thread-lines between hemlock twigs; *B*, the cocoon enlarged, seen obliquely, so as to show the triangular base.

While most of the epeïras are lovers of the daylight, a few of them are active at night. Some species of the Mascarene Islands and Madagascar weave webs in the twilight which they destroy at dawn. During the day they hide under heaps of leaves which they have gathered up into a kind of nest. Their webs are coarsely spun, as becomes a nomad who has to pitch his tent anew every night, and has no time to waste in elegance. Some of them, however, are not satisfied to pass their days in heaps of leaves, but construct a kind of nest out of thin silk as a more eligible habitation. Of these more refined spiders, the *Epeïra Borbonica*, with its cherry-colored body and lustrous black legs, fixes its night-web and its day-tent to the roofs of houses, the projections of rocks, and the branches of large trees. The much larger lilac-

colored *Epeïra livida* lives in similar luxury under the roofs of the Malagasy houses of the province of Imerina.

Leaving the grand epeïras, we may find, among vegetation and on walls, spiders whose weak proportions suggest their classifica-

FIG. 11.—*Nephila Chrysogaster*,* MALE AND FEMALE (one half natural size).

* This spider, whose name translated is the golden-bellied *Nephila*, has been described in "La Nature," by M. Maurice Maindron, from his observations of it in Java, the Moluccas, and New Guinea. Its nests are quite numerous in Java, and occupied several metres in the forests. They are constructed at an elevation above the ground corresponding with the height of a man's head, and are frequently annoying to persons passing through the wood. M. Maindron found the threads strong enough to pull off his *salacko*, or cork helmet, whenever it became entangled in them, and hold it suspended in their meshes. It is not unusual for the casual intruder into the nest to carry off the spider on his face, where the animal makes itself perfectly at home, and will promenade at its leisure over your face, shoulders, and arms, and will walk quietly the length of your body, in no seeming hurry to get away. —EDITOR.

tion among the most insignificant of beings; but they play an important part in nature, and often serve the interests of cultivators by causing the destruction of numerous noxious insects. They are the *Theridions*. Some of them form a web with wide meshes, while others weave a regular tissue that rests directly upon the grass or is fixed upon other plants. They usually lurk under their webs. The females make several cocoons for their young and keep them in their nets. Some species build a dome-shaped shelter out of foreign bodies fastened together with threads. Sometimes the grapes in vineyards are covered with a web so fine that it escapes notice, and the grape is swallowed, web, spider, and all. Walckenaër named this species *Theridium benignum*, considering it beneficent. It lives in part on insects injurious to the vine, and its little web protects the grapes against the attacks of animals fond of good fruit, but which will not venture to embarrass their mouths with spiders' webs.

Spiders very generally take pains to isolate themselves from one another. It is a matter of instinct. Were it not so, there would be perpetual slaughterings. Two spiders meeting never fail to be taken with a terrible desire to devour each other; but there are curious exceptions to this rule. Minute spiders, called *Linyphia*, are not afraid to attach their nets to the large-meshed webs of the great epeïras. Some linyphias, like the *Linyphia argyroides*, are of curious forms, from four to six millimetres in size at the largest, and are adorned, on a reddish-brown ground, with golden and silvery colors that shine with a bright luster. They may be remarked in the south of Europe and in Africa, stationed on a little net within the meshes of the web of a superb epeïra. A feature that adds to the singularity of the grouping at a certain period is the presence of the cocoon of the linyphia, hanging by a slight thread from the web of the larger species; but treachery sometimes invades this association. An epeïra and a linyphia had lived in the best of relations. The larger spider was taken away from her abode, leaving the cradle of her family without defense. On the next day the linyphia had opened the cocoon and was quietly eating the half-hatched epeïras.

There are legions of spiders, superior to all the others, living in the shade, which are distinguished in an extraordinary degree by their habits and instincts, and perhaps by their intelligence. These species do not make webs, but have some of them only a shift for a refuge, others simple abodes, and still others quite sumptuous habitations. In temperate climates many of them construct in secluded spots, from a fine white silk, well-finished tunnels in which they make a nearly permanent residence. The *Segestria* are the most important members of this group. The Florentine or perfidious segestrium, the larger species of the genus,

is of a rich black color, with antenna claws of bright emerald-green. It is spread through most of Europe, and lives under cornices, in the cracks of walls, and clefts of rock. While spiders of every other type have eight eyes, these tubicolar species have only six, those which look backward being wanting. They would be of no use to an animal living in a hole which is closed at one end.

In the intertropical regions, especially in the Antilles, Guiana, and Brazil, there live enormous spiders which the European

FIG. 12.—BIRD-EATING SPIDER KILLING A HUMMING-BIRD.

colonists call spider-crabs, and naturalists *mygales*. In them, suppleness and agility are united with muscular strength. Of all the representatives of the race which now engages our attention, the greatest physical power is exhibited in these. The mygales

produce but little silk, only enough to give them a foothold on a vertical plane, to bar the opening of their holes, and to bind their prey. Their simple claws are not adapted to the purposes of tools. They are hunters, and live in the hollows of trees, which they do not leave, except to go on the chase. Their eyes are not distributed over the body, like those of other spiders, but are grouped upon an eminence in the middle of the cephalic region, two in front, two on each side, and two looking hindward, in such positions as to command simultaneous views in every direction. The larger, dark-colored species go abroad usually in the dusk and at night, and capture with equal boldness large insects, small lizards, and humming-birds (Fig. 12).

The abbé Sauvage, of Madrid, in 1768, astonished the French Academy of Sciences with the declaration that he had found a spider "that did not stretch any kind of web, but hollowed a burrow in the ground like a rabbit, and added a movable door to it." The species had been observed on the road-sides, around Montpellier, and on the banks of the little river Lez. A little while previously, a traveler, Patrick Browne, had found a nest of similar construction to this, but less perfect, in Jamaica. Since the last century these animals have been called in France, mason-spiders; in England, trap-door spiders. Judged by the organism as a whole, they appear to be related to the mygales, but they present several differences in detail. Like the larger mygales, the trap-door spiders have stout bodies, large legs, eyes grouped on an eminence, and a dorsal buckler; but in the lower parts of their forceps-antennæ they have a row of points, a kind of rake, with spines on their paws, and teeth in their claws, which give a resemblance to microscopic combs. These are tools, working instruments, of which the mygales, compelled to find a home where they can, are destitute; naturalists call these spiders *ctenizas*.

The domiciles or burrows of the trap-door spiders are so well disguised that only an experienced observer can distinguish their presence on the surface of the ground. But, while without everything is as far as possible from suggesting a comfortable habitation, within the hole reign neatness, elegance, and graceful adjustments. These structures abound in the south of France and in nearly all of southern Europe. In compact earth, free from stones and gravel, they are built quite close to one another. Each one of them consists of a vertical hole or pit (Fig. 13), of a size proportioned to that of the architect, the cylindrical tube flaring toward the mouth. The walls are tapestried with the softest of satin, prepared from the silk which the animal spins. The entrance is most skillfully closed by a solid door, which can not easily be broken or pushed in. It is made of the material thrown out during the digging of the pit, the earthy particles being held together by the

silky matter. The doors are cut in a conical shape, to fit the flare of the cylinder, and will not yield under pressure from without. The exterior of the door is uneven and rough, like the ground round it, whereby the attention of enemies is diverted. Inside it is tapestried like the nest itself. The hinge, made of a compact silk, possesses great resisting power, and such elasticity that the trap infallibly falls back as soon as it ceases to be held up. The

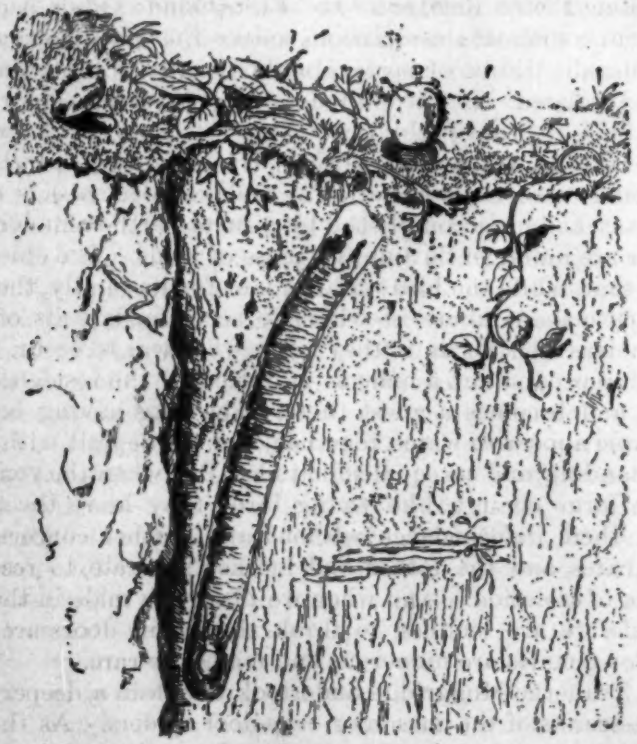

FIG. 12.—NEST OF ONE OF THE TRAP-DOOR SPIDERS (*Moggridge*). *D*, the door which closes naturally by its own elasticity and weight; *m*, marks of the spider's claws when she has held it down from inside.

place of a lock or bolt is taken by a series of little holes, like needle-pricks, arranged in a circle around the side of the door opposite the hinge. When the trap is down, the closing is so exact that the most delicate instrument can not be introduced into the interstice without danger of injury. If one tries to raise the trap, the spider, clinging to the walls of the pit, and inserting its claws into the holes of the cover, will make the most desperate efforts to keep it shut. In the evening, the spider comes out stealthily from its retreat, and goes to hunt its game in the fields. Having finished its meal, it returns to its home, lifts the trap-door with its claws, and disappears from view in an instant.

A much larger and finer species of cteniza than the one just

described inhabits Corsica, Sardinia, and the parts of Italy near Mentone. Its nest, usually built in the light red clay of the region, is a beautiful construction, from four to eight inches deep, and about five eighths of an inch in diameter. Like the others, these nests are usually grouped in considerable numbers, very near to one another; sometimes, indeed, they are contiguous. The first admirers of the art of these creatures, the "pioneer ctenizas"—the Italian Pietro Rossi, and the Frenchman Victor Audouin—were struck with this association, so like that of villages; for we do not usually think of spiders without conceiving them as solitary and isolated. But it is evident that these trap-door spiders do not hold that antipathy toward their fellows by race which is the rule in the Arachnidan world. While everywhere else, with this strange race, the association of males and females is only for an instant, and is accomplished by a surprise, the manners of the ctenizas are more gentle and like those of birds. The chief difference is that, while the bird builds a nest for its family, the cteniza has a permanent home in which to accommodate its offspring. The ctenizas behave as if they knew what was to occur. At the time of reproduction, a male is admitted to the residence of the female, and becomes a guest there. The eggs having been laid, the couple appear to watch together over the deposit with the best understanding, and an equal solicitude. But when the young have become large enough, like young birds, they leave the nest and assume their independence without any further concern for parental cares, and the father and mother separate, to resume the freedom of isolation. And when we observe a male in the cell of a female, we are inclined to think that many doors are open to him; for females are numerous and males are rare.

Mr. Traherne Moggridge undertook to obtain a deeper view of the life-secrets of the mason or trap-door spiders. As they work at night, it was not easy to surprise them when active in their labors; but much may be accomplished in the way of discovery by the exercise of patience and sagacity. Mr. Moggridge found it a good plan to follow the spider in building a new abode when its old one had been demolished. It executes its task speedily, without neglecting any detail, as if in obedience to a perfect method. The favorite places are the slopes of terraces and the banks of rivers; choosing a time, if it can, when the ground is moist, it clears away the earth with its claw-rake, and marks out the cylindrical hole. If there are any places in the walls that lack cohesion and where a slide may be anticipated, the animal, as if it were a graduate from a school of engineers, consolidates the parts with silk and weaves in successive layers the pretty satiny texture with which its house is to be adorned. It pursues its task in this way till the determined depth is reached. The tube having been con-

structed, the mason stretches a little web over the opening, sticking to it such particles of earth as it may find within its reach. A new sheet of silk is stretched over this, and a second layer is formed; and the process is repeated till the trap-door has obtained the requisite thickness. Then it shaves the edges to make the contours even, and the door is finished. If we compare several nests of the same species, we shall notice considerable differences in the merit of the work, from the greatest excellence down to comparative inferiority. Sometimes we find nests with two doors and two vestibules. In the majority of instances of this kind, one of the trap-doors has been condemned. Sometimes the hole is provided with an ascending annex, not opening out upon the surface but provided with an interior door separating a smaller chamber from the main abode. This puts the spider to advantage against an enemy that may have gained access to the main chamber. The ctenizas take a variety of precautions against being discovered. Sometimes the trap-doors are disguised by looking in no way different from the ground around them. In other places they are concealed by means of moss, lichen, grass-blades, bits of straw, or whatever foreign bodies it may be convenient to strew around and over them. The masons are very diligent in their work. If one of them is deprived of his retreat, he will replace it in a night or two. But, notwithstanding their skill in construction, the best observers affirm that young spiders will not abandon a nest when it has become too narrow for them. They have the art of enlarging them so that they shall always be at ease within. The Austrian naturalist, Erber, met in the island of Tinos, in 1868, a previously unknown species. He studied its habits and found that it came out of its nest every evening to make an excursion, but left its door open, fastening it back to some stone or plant-stalk, protecting the entrance by weaving over it a net which it destroyed on its return in the morning.

The trap-door spiders have been seen in many parts of the globe, but usually in countries where a high temperature prevails. They are abundant in the countries around the Mediterranean, and have been observed in the Austral lands and in America. A species of very fair proportions, the *Cteniza Californica*, lives in California. A living specimen was kept and observed by M. Hippolyte Lucas for four months in the *Muséum d'Histoire naturelle*. The observer succeeded in opening the door of the cell and presenting the spider with a fly. The cteniza, hungry after a long voyage, seized the fly at the entrance of its burrow, but retired to the back upon the attempt being made to draw it out; and it continued suspicious, even toward its friend. One night, after it had had a few days of good feeding, it sealed the circumference of its

door, which it was annoyed to see opened by a stranger, and on the next day a new trap was constructed at a short distance from the former one. Had the creature thought that the new door would be unknown to the person who had disturbed it at the old one? When its last hour was approaching, the California mason crept slowly out from its home, and was afterward picked up dead on the ground at some distance from the spot.

In the world of spiders, as we have seen it under its varying aspects, a fundamental unity of character prevails in essentials, with an attracting diversity in secondary things. While the creatures are highly organized, they are very unequally endowed in fortune, in physical advantages, and in resources to help them in the struggle for existence. Notwithstanding their sagacity, they do not inspire the interest or sympathy that is bestowed upon insects that work in common and form social organizations. In their solitary life they represent individual egotism in its most absolute sense. Yet they are all alike watchful mothers, displaying an unparalleled solicitude for their offspring—a solicitude which we might even call tenderness. While with most other animals the sexual relations promote kindly and social qualities, the relations between male and female spiders are generally very much strained. Yet, as if Nature repelled a rule absolutely without exception, we have witnessed some pleasant instances of union among a few privileged species. The instincts of spiders have revealed themselves in striking forms, while some signs of a higher faculty have also appeared. And does not a being which shows such just appreciation of situations, and can repair damages to its structures in so irreproachable a manner, show evidence of a reasoning faculty? In truth, observation of the acts and faculties of the humblest creatures is not without use in adding to our knowledge of the wonderful phenomena which are the subjects of psychology.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE advance that has taken place in scientific and in all thought is wonderfully illustrated in the history of the authorship of the "Vestiges of Creation." Robert Chambers's connection with the work was well understood in private circles when the book appeared, but was never avowed; and he was obliged to forego a candidacy for public office for fear that the matter would be stirred. This was because there was danger that the house of the Chambers's would be ruined if it became publicly known that one of its members was the author of so pernicious a book. Compare this situation with that of the present, when evolution has become a general scientific fact, exerting its acknowledged influence on religious thought, almost without longer exciting remark!

WHAT IS KNOWN OF THE EARTH.*

By Lieut.-General R. STRACHEY, F. R. S.

SO thorough has been the success with which recent labors of geographical research have been prosecuted, that it would now be hardly possible to describe what is known of the earth, otherwise than by pointing to what is still unknown, and this might be summarized in a very few words.

Besides the interior of Borneo and New Guinea, and the portion of Central Africa where Stanley is for the present moment lost to view, no considerable part of the earth's surface is unexplored, with the exception of the polar regions, which have till now proved inaccessible. The maps of the interior of Africa now supply trustworthy representations of a vast system of rivers, lakes, and mountains, till recently wholly unknown to the civilized world, and what remains to be done is little more than to fill in the details of well-ascertained large outlines. Australia has been crossed and recrossed in many directions. The darkness which so long enveloped Central Asia has been entirely cleared away, and, though parts of Thibet are yet to be visited, the true nature of the central plain lying between that country and Siberia is completely known. The geographical features of North America are little less perfectly mapped than those of Europe; but large parts of the interior of South America, much of which is covered by forest, are still unsurveyed. The southern border of the North Polar Sea, and the very complicated system of islands and channels along the northern margin of the American continent, between Bering Strait and Greenland, have been precisely delineated, and the boundary of the same sea along northern Asia has also been determined. The highest northern latitude reached is about 83¼° north—that is, within five hundred miles of the pole. The nearest approach to the south pole has been in 78° 11′ south, but the difficulties arising from climate have till now stood in the way of any satisfactory survey of the land seen at some few points in the antarctic area.

The figure of the earth, and its existing features, have had their origin in a former state of the planet, during which it has been subject to the gradual changes that accompanied its cooling from a previously much higher temperature. The forces of nature which are still at work, including the most wonderful of all, life, have operated upon the globe while it thus passed through the stages which have led to what it now is; producing varied conditions of surface, from which have arisen, as direct consequences,

* From "Lectures on Geography," delivered before the University of Cambridge.

differences of climate, and corresponding variations in the forms and distribution of living creatures, vegetable and animal. Thus it is that while every part of the earth has its own characteristics, the general system of nature is one and the same everywhere; the special characters of the several regions being due to the action of local features or conditions, which are no sooner called into existence than they in turn become secondary efficient causes of the infinitely varied phenomena that our globe presents to us. In this manner has been evolved the face of nature as we now see it; nature which, working with never-varying forces, appears to man in the present as his type of stability, while it is constantly leading, through ever-varying forms, from the hidden shapes of an impenetrable past to those of an unknown future.

The influence of the movements and figure of the earth may everywhere be traced among the phenomena brought to our knowledge by the more and more complete exploration of its surface. The daily and annual motions of the globe, subject to the effects of the spherical form of the earth and the direction of its axis of rotation, determine at all parts of its surface the amount of heat and light received from the sun, and thus regulate all the conditions of existence upon it; they give rise to the varying length of days and of seasons at different places, and to a multitude of recurring phenomena which characterize or influence the animate and inanimate world. In whatever direction we turn are to be found alternations of what may be termed terrestrial work and rest, day and night, summer and winter, periodical winds extending over longer or shorter periods, seasons of rain and dry weather. The tides of the ocean, and the less apparent though not less regular periodical oscillations of the atmosphere, as well as the little understood variations in terrestrial magnetism, are consequences of the same general causes.

The remarkable force inherent in the globe, known as terrestrial magnetism, which gives a determinate direction to a freely suspended magnetic needle, and is of inestimable value to man, has long been the subject of observation and study. It is now established that there are two magnetic poles, one in each hemisphere, at which the needle would point vertically upward and downward. Their position, which is not coincident with the geographical poles, is found to have varied according to some yet unknown law. In the year 1878 the northern pole was in latitude 70° north, longitude 96° west, and the southern in latitude 73½° south, longitude 147½° east. Between these poles, a line that has been termed the magnetic equator, where the needle assumes a horizontal position, is found to pass round the earth, following an unsymmetrical line, which in 1878 lay almost wholly to the north of the terrestrial equator in the hemisphere east of Greenwich,

and to the south of it in the western hemisphere. It further appears that the magnetic force is not evenly distributed on the earth, and that the points of maximum intensity do not coincide with either of the magnetic poles. In the northern hemisphere there are two foci of maximum force of unequal intensity, the most powerful lying at about latitude 52° north, longitude 92° west, near the great American lakes, the weaker in latitude 65° north, longitude 115° east, in Siberia. For the southern hemisphere, the available data are far less numerous, and the determination of the foci of force is less reliable. It is, however, believed that here also there are two points of maximum, of nearly equal power, and not far removed from one another, one in latitude 65° south, longitude 140° east, the other in latitude 50° south, longitude 120° east. The unit by which magnetic force is measured has been assumed, adopting English standards of weight and length, to be that which would impart to a weight of one grain a velocity of one foot in one second of time. On this scale the magnetic force, where least, is found to be 6·0; the northern maxima are 14·2 and 13·3 respectively, and each of the southern 15·2. The declination, or variation of the direction of the needle from the true meridian, is a consequence of these unequal forces operating upon it, the westerly or easterly tendency of the needle (as the case may be) following the geographical position of the place of observation in its relation to the several foci of force, with a general result of considerable complexity. Up to the sixtieth parallel of latitude, north or south, the declination, whether easterly or westerly, rarely exceeds 30°; and, speaking generally, it is easterly in the Pacific and westerly in the Atlantic and Indian Oceans. Near the poles, where the dip becomes high, the directive force of the earth's magnetism becomes much reduced, and the magnetic needle becomes comparatively unreliable and of little use. The nature and mode of operation of magnetism, and the allied phenomena of electricity, continue to be subjects of speculation, no explanation of them having yet been proposed, such as that which refers heat and light to the vibrations of an elastic medium. Our knowledge of the phenomena of terrestrial magnetism therefore still remains in the empirical stage; they are, however, held to show that the earth's magnetism is distributed through its mass, and that the magnetic force either wholly or mainly resides in the interior, and can not be attributed to external influences, though it may be affected by them. Whether or not geographical features have any influence on the distribution of this force is doubtful. Observation shows that all the elements of the earth's magnetism not only vary from place to place, but from time to time; the variations being in some cases periodical and dependent on the time of the day or the season of the year,

and others extending, with no apparent tendency to periodicity, over considerable lengths of time. The manner in which these variations occur is still a matter of investigation, and their causes are doubtful, but the diurnal and annual changes are probably connected with changes of the temperature of the earth or its atmosphere, and may be influenced by geographical conditions. The non-periodical changes that have been recorded are very large. These variations have been attributed by some to changes going on in the condition of the interior of the earth, and by others to external influences; but they continue to be among the most obscure of physical phenomena. Besides the variations above mentioned, there also arise other irregular disturbances of the indications of the magnetic needle, of short duration, which are sometimes spoken of as magnetic storms. They occur with a frequency which shows a tendency to periodicity, diurnal or annual, and often almost simultaneously at distant parts of the earth, with nearly identical effects, and with a marked increase in intensity with increase of latitude. They likewise exhibit a period of increase and decrease coinciding with that observed in the sun-spot area, thus giving additional reason to connect them with modifications of the magnetic or electric condition of the earth or atmosphere arising in some manner from the action of the sun. The probable connection of these disturbances with the electrical condition of the atmosphere is indicated by their frequent occurrence simultaneously with appearances of the aurora, and with electrical earth-currents. The frequent, if not continuous, display of the aurora in the vicinity of the magnetic poles, further suggests a relation between the electrical and magnetic conditions of the earth. The true nature of all these phenomena is, however, still very imperfectly ascertained.

A very little observation and thought threw discredit on the ancient cosmogonies, and showed that they failed to give any satisfactory solution of the problems submitted by the advance of knowledge. If the extravagant myths of Asiatic origin, which peopled the earth millions of years ago with races of anthropomorphic demigods, and heroes descended from the sun and moon, could not bear the test of facts, neither have those traditions fared better which unveil the earth fully equipped with all the present forms of life and specially prepared to be the dwelling-place of man, some few thousand years ago. Precise observation has now supplied satisfactory proof that the earth's surface, with all that is on it, has been evolved through countless ages, by a process of constant change. Those features that at first sight appear most permanent, yet in detail undergo perpetual modification, under the operation of forces which are inherent in the materials of which the earth is made up, or are developed by its

movements, and by its loss or gain of heat. Every mountain, however lofty, is being thrown down; every rock, however hard, is being worn away; and every sea, however deep, is being filled up. The destructive agencies of nature are in never-ceasing activity; the erosive and dissolving power of water in its various forms, the disintegrating forces of heat and cold, the chemical modification of substances, the mechanical effects produced by winds and other agencies, the operation of vegetable and animal organisms, and the arts and contrivances of man, combine in the warfare against what is. But hand in hand with this destruction—nay, as a part of it—there is everywhere to be found corresponding reconstruction, for untiring nature immediately builds up again that which it has just thrown down. If continents are disappearing in one direction, they are rising into fresh existence in another. Though the ocean tears down the cliffs against which it beats, the earth takes its revenge by upheaving the ocean's bed.

When we look back, by the help of geological science, to the more remote past, through the epochs preceding our own, we find complete evidence that the globe has passed in succession through an infinitude of anterior states, by means of small modifications extending over a vast period of time, but not differing in essentials from those which we now see to be going on. There are still preserved to us the remains of land and marine plants and animals—which lived, produced other generations, and died—possessed of organs proving that they were under the influence of the heat and light of the sun; indications of seas whose waves rose before the winds, breaking down cliffs, and forming beaches of bowlders and pebbles; of tides and currents spreading out banks of sand and mud, on which are left the impress of the ripple of the water, of drops of rain, and of the tracks of animals; of volcanoes pouring forth streams of lava; and all these appearances are precisely similar to those we observe at the present day as the result of forces which we see actually in operation. Pushing back our inquiries, we at last reach the point where the apparent cessation, or failure of evidence, of former terrestrial conditions such as now exist, requires us to consider the relation in which our planet stands to other bodies in celestial space; and, vast though the gulf be that separates us from these, science has been able to bridge it. By means of spectroscopic analysis, it has been established that the constituent elements of the sun and other heavenly bodies are substantially the same as those of the earth. The examination of the meteorites which have fallen on the earth from the interplanetary spaces, shows that they contain nothing foreign to the constituents of the earth. The inference seems legitimate, corroborated as it is by the manifest physical connection between the sun and the planetary bodies circulating

around it, that the whole solar system is formed of the same kinds of matter, and is subject to the same general physical laws. These conclusions further support the supposition that the earth and other planets have been formed by the aggregation of matter once diffused in space around the sun; that the first consequence of this aggregation was to develop intense heat in the consolidating masses; that the heat thus generated in the terrestrial sphere was subsequently lost by radiation; and that the surface at length cooled and became a solid crust, inclosing a nucleus of much higher temperature. The heat of the interior of the globe increases about 1° Fahr. for every fifty or sixty feet of depth below the surface. The surface appears to have now reached a temperature which is virtually fixed, the gain of heat from the sun being just compensated by the loss from radiation into surrounding space. As the exterior gradually cooled, contractions necessarily ensued, producing change of form and dimensions; and to these, acting in combination with gravity, are, no doubt, largely due the great irregularities of the earth's surface. The strains set up by these forces must have continued to cause movements for a vastly prolonged period, and are doubtless still in action. But the irregularities of the surface constitute only a small part of the effects of internal heat on the earth, and mineralogy is the branch of science to which reference must be made for a knowledge of the many simple and compound substances that have issued, under the operation of chemical forces, from the vast laboratory contained within the cooling crust of the once incandescent globe.

During the passage of the globe to its present state many wonderful changes must have taken place. The ocean, after its condensation from a gaseous state into that of liquid, must have long continued in a state of ebullition, or bordering on it, surrounded by an atmosphere densely charged with watery vapor. Apart, however, from the movements in the solid crust of the earth caused by its gradual cooling and contraction, its early higher temperature hardly enters directly into any of the considerations that arise in connection with its present climate; and it must remain doubtful how long and to what extent those conditions of climate which interest us most, as having occurred during the period in which the existence of life is indicated, have been affected by such early higher temperature.

In the absence of any direct means of ascertaining the condition of the earth's interior, aid has been sought from mathematical science, by which it has been established that the thickness of the solid outer shell of the earth must be considerable; and that if the interior is in a fluid state at all, which is very doubful, it must be covered by a great thickness (probably not less than several hundred miles) of solid, comparatively unyield-

ing matter; and it is argued, with apparent force, that no passage can exist by which molten matter, if there be any, could ascend from such depths to the surface. Recent speculation has consequently suggested that even volcanic phenomena may be consequences of the heat developed by intense pressures set up by the mechanical forces concerned in the movements of the cooling outer solid crust, and that they are not immediate results of the very high temperature which almost certainly still subsists at great depths in the earth's interior. A more probable explanation would seem to be that by some local or partial removal of pressure in the otherwise solid interior, a portion of intensely heated matter is able to pass into the fluid state, and so finds a way through some fissure to the surface.

Should any still hesitate to believe that vast mountains like the Himalaya or the Andes, and analogous depressions of the bed of the ocean, can have been produced by a mere secular change of the earth's temperature, I would remind them that the forces called into action by the earth are proportionate to its magnitude, and that their effects must be on a corresponding scale. It has been calculated on sound data that the contraction of the diameter of the earth, consequent on the fall of temperature from a fluid state to its present condition, has been about one hundred and ninety miles. At this rate a subsidence of five miles, which is the approximate greatest depth of the ocean, would correspond to a fall of temperature of about 200° Fahr. But the elevations and depressions of the earth's surface were probably produced by a comparatively much smaller loss of heat, and were due rather to tangential strains than to direct up-thrust or subsidence. An illustration may assist in forming a proper estimate of the irregularities of the earth's surface, which, though apparently great, are insignificant when viewed in relation to its actual dimensions. This hall might contain a globe forty feet in diameter. If this globe represented the earth it would be on a scale of one foot to about 200 miles; and one inch would be equivalent to a distance of 16⅔ miles, or 88,000 feet. On such a globe the difference between the polar and equatorial diameters would be less than one inch, and the greatest elevations in Britain would be about the thickness of a threepenny-bit. The highest mountains and the deepest seas would be shown by elevations and depressions of hardly more than one third of an inch; and if they were distributed as such features are on the earth, they would be visible only with difficulty, and to the unaided eyes of a casual observer would hardly interfere with the apparent perfect smoothness of the globe's surface.

The conception of the vast duration of geological time is one with which most persons are now more or less familiar. It is

well to remember that great though the changes in human affairs have been since the most remote epochs of which there are records in monument or history, nothing indicates that within this period there has occurred any appreciable modification of the main outlines of land and sea, or of the conditions of climate, or of the general characters of living creatures. The distance that separates us from those days is as nothing when compared to the remoteness of past geological ages. No numerical estimate on which reliance can be placed has yet been made of the duration even of that portion of geological time which is nearest to us; and we can say no more than that the earth's past history, as recorded in what we now find upon it, or as inferred from what we find, probably extends over hundreds of thousands or millions of years. It is through the facts of geography, as now acquired and interpreted, that the geologist is supplied with the means of arriving at the true signification of much that occurred in past time, the traces of which survive in physical features or organic forms. He finds that the most important agencies in determining and modifying the present conditions of existence on the earth, whether as affecting inorganic nature or organic beings, are closely connected with the actual distribution of land and sea, and the configuration of the surface; and he learns that it is through these agencies that he must seek to unravel the intricacies of the past.

The study of geology, in its turn, enables the geographer to understand many things that would otherwise be unintelligible to him. He thus learns how the boundaries of sea and land have been determined; where connections formerly existing have been severed; how islands have risen from the ocean and may be sinking below it; to what causes are due the rocky coasts and headlands, the indentations of the coasts, the formation of bays and fiords; at what time and by what means mountains have been raised up, plains laid out, valleys excavated, and the courses of rivers and positions of lakes fixed; and he is taught the constituents and qualities of the materials forming the surface of the earth, of the soil upon it, and of the minerals beneath it. And as a better insight is obtained into the natural relations of the mountains, the plains, the valleys, rivers, lakes, and seas, the conviction arises that the ever-diversified details of the face of the globe are in no sense accidents or fortuitous results, little worthy, as such, of admiration unless for their picturesque forms or wonderful proportions; but that they are the direct, orderly, and necessary outcome of the action of forces simple in themselves, and operating in accordance with well-known and invariable physical and mechanical laws. The perception of general characteristics of structure among the various features of the earth's surface that pass

under our review is, indeed, too often overshadowed and obscured by their magnitude, by the multitude of their details, and by the variety of their forms, which at first produce impressions of hopeless confusion; but, when once the idea of subordination to common laws is duly conceived, it receives confirmation at every fresh step taken.

The area of the dry land is very greatly exceeded by that which is covered with water. The whole surface of the earth being 197,000,000 square miles, about 55,000,000 are land and 142,000,000 water. The average height of the land above the sea-level is also very much less than the average depth of the sea-bottom below that level; so that a rearrangement of the surface is quite possible by which the whole of the land might be submerged with comparatively little disturbance of the present level of the sea, or reduction of its average depth. The highest measured peak of the Himalaya, known as Mount Everest, which is also the highest in the world accurately determined, just rises 29,000 feet above the sea-level, but such elevations even as 15,000 feet are, elsewhere, with the sole exception of parts of Thibet, confined to isolated peaks or very narrow bands along the crests of a few of the highest mountain-ranges. The area above 12,000 feet is about two per cent of the whole land, and that above 6,000 less than nine per cent. From a careful computation recently made, it would appear that the mean height of the surface of the land above the sea-level is about 2,250 feet; the continental areas having the following elevations: Europe, 939 feet; Asia, 3,073 feet; North America, 1,888 feet; South America, 2,078 feet; Australia, 805 feet. The greatest depths measured in the ocean exceed 27,000 feet, and it has been estimated that the mean depth is about 12,500 feet. About five per cent of the ocean area is less than 600 feet in depth, and a somewhat smaller proportion, more than 18,000 feet. About seventeen per cent is less than 3,000 feet. The ocean-bed generally appears to present very extensive, comparatively uniform plateaus, varied only by moderate undulations, possibly to be attributed to contractions of the earth's crust caused by cooling; these range in depth from 12,000 to 17,000 feet, and their general direction maintains a rough parallelism with that of the neighboring continents. Submarine deposits derived from the land do not extend beyond 300 or 400 miles from the shore; but at great depths deposits are being formed with extreme slowness, which are probably derived from decomposed organisms, or from cosmic, volcanic, or other matter, carried down through the water. Accepting these estimates, it will appear that the volume of land above the sea-level is about one fifteenth part only of the volume of the ocean.

With the latest additions made to our knowledge of the depth

of the ocean there has also been acquired an altogether new series of facts bearing on its temperature, and its capacity for supporting life. The variations of heat and cold, due to change of season or to day and night, which affect the surface, descend to a comparatively small depth, being greatly reduced in the first 100 fathoms, and below that depth for the most part eliminated, so that at 300 or 400 fathoms an approximately uniform temperature is met with. With increased temperature at the surface, there is increased evaporation, followed by greater density, by reason of which the surface water sinks, and the higher surface temperature is partially communicated to the subjacent strata. From the mobility of water, and its high specific heat, which is almost four times that of the materials composing the land-surface, the sea-surface can never acquire a very high temperature. At the same time, the evaporation which is constantly going on from the whole surface of the ocean leads to a large quantity of the heat it receives from the sun becoming latent, and powerfully aids in preventing an accumulation of heat. These facts render the ocean one of the most important factors of terrestrial existence; it furnishes to the atmosphere the moisture which is one of the essentials of life, and serves by the circulation of its waters, and the diffusion of vapor derived from it, to equalize the temperature of the globe, by moderating the extremes both of heat and cold. Hence the greater or less proximity of the sea directly affects all conditions of climate. The circulation of the waters of the ocean, which is set up chiefly by the action of winds on the surface, but in part by variations of temperature and of density, and by the effects of evaporation, is controlled in all its details by geographical features.

Among the influences which give to the earth the characteristics that most immediately affect its fitness for occupation by man and the support of life generally, those due to the atmosphere are, without doubt, the most prominent. These, under the designation of climate, are constantly affecting us. But of all recognized branches of science, that which treats of the atmosphere—meteorology—is at the present time certainly the most backward. The reasons are not far to seek. The air is invisible, and in its upper regions inaccessible. The changes it undergoes are difficult to observe, and, from their great complexity, difficult to grasp, while what we know of them is almost wholly confined to the immediate proximity of the earth. It is pretty certain that the most important among the causes which operate on the atmosphere are changes of temperature; but the application of mathematical reasoning to the movements of an elastic fluid such as the air, charged with watery vapor, when submitted to changes of temperature upon a rotating sphere, presents very serious difficulties,

and little has been done to grapple with them. What is known of these subjects is as yet almost exclusively empirical. Instrumental appliances are here far in advance of theories, and it is not to be disguised that great waste of labor too frequently results from an exaggerated refinement in observation, and subsequent numerical computation, which has no real value. The variations of the temperature, of the pressure, and of the motion of the air, and of the quantity of vapor it contains, give rise to the great series of phenomena which are included under the general term climate. Of these variations the primary causes are the action and reaction of the mechanical and chemical changes set up by the sun's heat as influenced by the earth's motion, terrestrial position, and the condition of its surface, as well as by fluctuations of the sun's heat itself, though of these last we know too little to do more than recognize their presence.

The conditions which determine at any place the greater or less degree and duration of direct exposure to solar radiation, and therefore the quantity of heat received there, are position in relation to latitude, combined with the diurnal and annual movements of the earth. The nature of the surface regulates the local accumulation of heat, by reason of the varying power of absorption or radiation possessed by different substances; while with elevation above the sea-level as the density of the air becomes less, the sensible temperature and the quantity of watery vapor are subject to corresponding change. The whole of the results thus produced, moreover, are modified by movements in the air consequent on atmospheric changes from place to place, or from time to time.

The inequalities of the earth's surface, which are insignificant when viewed in relation to the whole globe, are of the greatest importance in relation to the atmosphere. For, owing to the laws of elastic fluids, the great mass of the air and of the watery vapor it contains are concentrated very near the surface. One fourth of the air and one half of the vapor are found below 8,000 feet from the sea-level; one half of the air and nine tenths of the vapor are below 19,000 feet, which hardly exceeds the average elevation of the highest ranges of the Himalaya Mountains; while three fourths of the air and virtually the whole effective vapor lie below 30,000 feet, and therefore within the influence of the highest summits of those mountains. That portion of the atmosphere which is nearest the surface is manifestly the most likely to be acted upon by irregularities of relief, and by local variations in the power of absorbing or radiating heat or diffusing vapor. Hence it is certain that it is the movements of the lower strata of the atmosphere that chiefly affect all conditions of climate, though no doubt there are great movements in the upper regions to bring

about the restoration of equilibrium, which is being constantly disturbed from below. The principal periodical winds—such as the trade-winds, the monsoons, the land and sea breezes—are found to be essentially dependent on periodical variations of atmospheric pressure, accompanying variations of temperature due to geographical position or surface conditions. The proximate causes of the more characteristic winds have also been well made out. These, too, are due to atmospheric disturbances producing areas of high or low pressure; the rapidity and intensity of the development of which, with the direction of their paths and their position, determine the force of the wind, the direction in which it blows, and the manner in which it veers or backs, that is, changes its direction. But how the changes of pressure are determined, and what causes the transfer of the disturbed area, commonly under the form of an atmospheric eddy or vortex, in a definite direction, usually from west to east, is still to be ascertained; though here, too, it is obvious that the distribution of the land and sea areas, and of the ocean-currents, on which the temperature of the superincumbent air so immediately depends, combined with the rotatory motion of the earth, are among the principal agencies at work.

Among the most intricate problems of meteorology are those relating to the evaporation of water, the formation of vapor and its diffusion and suspension in the air, and its condensation as cloud, rain, or snow. The low specific gravity of aqueous vapor, and the consequent evaporation that releases it at the earth's surface, tend to diffuse it in accordance with the mechanical laws which govern elastic fluids. But the reduction of the temperature of the air in ascending above the surface renders this diffusion impossible beyond a certain point; and observation shows that the quantity of vapor actually existing in the upper parts of the atmosphere is mainly dependent on temperature, and amounts to not more than one fourth part of what would be present if it were diffused freely and simply obeyed the law of hydrostatic pressure. It follows that a height in the atmosphere is at length necessarily reached where condensation must take place and clouds or rains be formed, and that, speaking generally, the vapor in the upper strata of the air is constantly tending to a condition of unstable equilibrium, from which it may readily be once more restored to the earth in the shape of water. This sufficiently accounts for the rarity of a perfectly cloudless sky, which indeed can hardly exist excepting where such a movement of the air is going on as will carry off the aqueous vapor, as fast as it is formed by evaporation, to a region where the temperature is high enough to prevent its condensation.

The great activity of the air in discharging the functions of

equalizing temperature and distributing moisture over the earth is remarkable. If the whole quantity of moisture in the air at any moment were condensed so as to leave it absolutely dry, the resulting stratum of water if distributed evenly over the whole earth would be less than one inch in depth. Yet it is estimated (though perhaps on insufficient data) that the mean rainfall over the whole globe is not less than sixty inches in the year, and falls of ten times this amount are known to occur in some localities. Observations of the velocity of the wind at marine stations show that these results are due to the almost unceasing passage of air highly charged with vapor over the regions where and during the time in which rain thus falls, and to the unceasing renewal of the supply of moisture by evaporation. The relatively very large sea-area has an important effect in maintaining the supply of the rain that falls on the land; and the immediate dependence of rainfall on local geographical features is too well known to call for more than a passing remark.

A few words will indicate the magnitude of the forces which are called into silent and comparatively unobserved operation in the atmosphere by the sun's heat in the production and recondensation of aqueous vapor. It has, as I noticed, been estimated that on the average five feet of water falls annually as rain over the whole earth. Supposing that condensation takes place at an average height of 3,000 feet above the surface, the force of evaporation must be equivalent to a power capable of lifting five feet of water, over the whole surface of the globe, 3,000 feet during the year. This, not reckoning the force required for the transport of the rain in a horizontal direction, would involve lifting 322,000,000 pounds of water 3,000 feet in every minute, which would require about 300,000,000,000 horse-power constantly in operation. Of the huge energies thus exerted a very small part is transferred to the waters that run back through rivers to the sea, and a still smaller fraction is utilized by man in his water-mills; the remainder is dissipated in celestial space. A well-known consequence of the physical properties of the air is the gradual reduction of temperature observed in ascending mountains. This, amounting to 1° for about 300 feet of elevation, gradually produces a change of conditions similar to that caused by passing from the equator toward the poles, and at the greatest elevations an arctic climate is established even under a tropical sun. Among the sublimest sights furnished by nature are the great ranges of mountains which traverse or approach the tropics. Rising into the regions of perpetual snow, they discharge important functions in the economy of the globe. By the intrusion of the solid terrestrial surface into the upper part of the atmosphere, the low temperature there, which otherwise could have produced no effect on the

earth, is brought into active operation. Great rivers spring from the melting fields of snow and ice that crown the mountain-summits, and, swollen by the copious condensation of rain on their slopes, flow down to the plains below, which are fertilized by their perennial waters.

THE LAST STAGES IN THE GENEALOGY OF MAN.*

By M. PAUL TOPINARD.

OUR lectures hitherto have shown us that science has not yet succeeded in casting a clear light on the exact connections of the placental mammalia, and that it is still ignorant of the precise ways, direct or indirect, by which the present orders and families have been derived. Haeckel's genealogy has been the point of departure for numerous essays, which have rendered immense services; but, as the author himself declares, it is only a first sketch, and will have to be revised hereafter. It has been shown by our lectures that the present orders, families, and genera are the product of a long evolution and successive transformations, and did not exist when the first placental mammalia appeared, and when the first feebly determinative evolutionary movement of differentiation and reduplication of types, which led to existing forms, was manifested in the marsupials. It is also shown that the progressive passage from the marsupial fauna of that time to the existing fauna did not take place by a single series of species for each order, family, or genus, but in all the cases in which science is in possession of sufficient documents, by multiple series, anastomosing, intercrossing one another, and often constituting an inextricable network.

Here and there the advance seems to have been more direct, as in the ungulates, the carnivores, the cheiropteres, and the pinnipeds or aquatic carnivora, while in other orders, such as the insectivora and the rodents, it seems to have been in an exceedingly complicated way. That branch which, according to Haeckel, leads to man, is the one that interests us most. Let us consider, then, the station which succeeds that of the marsupials, the eighteenth from the moneres in Haeckel's genealogy, the lemurs.

The lemurs have been ranked among the quadrumana by Geoffroy Saint-Hilaire, Cuvier, De Blainville, Duvernoy and Milne-Edwards—that is, separated from man; and among the primates, or in the same order with man, by Linnæus, Lesson, Huxley, and Broca. Vogt and Haeckel call them prosimians, the Germans half-apes, and the French sometimes false apes. The dominant question in our investigation is, therefore, where they belong:

* From a lecture at the *École d'Anthropologie*, March 21, 1888.

should they be called prosimians, or should they figure among the primates?

The primates might be well defined by saying that they are placentary mammalia, non-aquatic—which excludes the cetaceans, sirens, and pinnipeds; without hoofs—which excludes the ungulates and proboscidians; having three kinds of teeth—which removes the rodents and edentata; and having molars neither with cutting blades nor with sharp, conical points—which excludes the carnivora and insectivora. They have no absolutely peculiar characters in common, naturalists not regarding the type of the cerebral circumvolutions. They have a discoidal placenta, and a uterus with a cavity not two-horned; the cheiroptera or bats have likewise the third characteristic. They have two pectoral mammæ; but so have the bats and the lamantins.

The teeth vary among them as to number, form, and permanence. They appear more specialized, brought nearer to one another, and more fixed in their general form, as we ascend toward man. There are four stages in the last category—the lemurs, the monkeys of the old continent, the monkeys of the new continent, and man.

The replacement of claws by nails forms one of the most important characteristics of the primates. Claws are designed and formed for attack and defense; the hoofs of the ungulates form hard soles for the feet, protecting them from contact with the ground and facilitating the march of the animal; while the nails are so shaped as to be adapted to the purpose of prehension. This adaptation is more or less perfect, and extends to more or fewer fingers among the primates, permitting another division into the perfect primates, like man and all the monkeys but one group, and imperfect primates. Another adaptive characteristic, the corollary of the nails, is the well-developed thumb, removed from the other fingers, and opposable to them. More completely than they, it also indicates an organ made to clasp, to seize. The primates may also be divided by this feature into three groups: Man, with whom the thumb is opposable only on the fore-limbs; the monkeys, with which it is opposable on all four of the limbs; and the imperfect primates, with which the adaptation is less exact or less marked on the hinder than on the fore limbs. Other characteristics, usually graduated in the ascending series of the primates, might be mentioned; but these are enough for our purpose.

To regard the primates in this way is a little to prejudge the solution we are seeking. From the instant we suppose a progressive development of characteristics in the series and divide the primates into superior, medium, and inferior, we are tempted to be indulgent in respect to characteristics which may be little accentuated or wanting in the last. From this, to assuming that

the lower primates are simply the beginning of the series, the transition from the other orders to that of the primates, is but a step. The lemurs furnish most of the imperfect primates of which we have spoken. They included or include three groups of animals—the *Galeopitheci*, the *Cheiromys*, and the lemurs proper.

The *Galeopitheci*, or flying-cats, inhabit the Sunda Islands, the Moluccas, and the Philippine Islands. They furnish one of the examples of the difficulty of placing in our classification certain groups qualified with paradoxical characteristics, for the reason that they are transitional groups having some right to be put in several.

The *Cheiromys* include only one genus, the aye-aye of Madagascar. It resembles the squirrel, but has features also of the ape and the lemur. By dentition it is an insectivore or lemur in infancy and a rodent in adult age. It is evidently a primate at the start, but a species hesitating whether it shall continue a primate or become a rodent.

The lemurs proper are divided into the fossil and the recent. The former appear in the Eocene when there existed parallel with them the marsupials in a declining stage and the first placental mammals—the carnivora, rodents, ungulates, and the insectivora. Europe has furnished five genera of them and America more, the most important among them being the *Anaptomorphus*, from which Mr. Cope makes man a direct derivative. The recent species are distributed in three geographical groups, the first and most numerous being confined to the island of Madagascar, the second to that island and Africa south of the Sahara, and the third living in the island of Ceylon, the Malacca Peninsula, the Moluccas, and the Philippines, or the regions which Haeckel supposes to constitute the remains of the vast southern continent which he calls lemurian.

The lemurs are tree-dwelling and nocturnal animals. They have four opposable thumbs with the exception of the tarsier, which has only the hind thumbs opposable. All their fingers, as a rule, have nails except the hind forefinger, which has a claw, or in the loris, the fore little finger; but the nails are all badly shaped and seem transitional from claws. A general formula can not be framed for the teeth. The number varies from thirty to thirty-six.

All these facts tend to establish that the lemurs have not a fixed, homogeneous type, but that they constitute a transitional group from animals with claws to animals with nails. They may consequently be regarded as the first or perhaps the second stage (regarding the *Cheiromys* as the first) toward the better characterized monkeys; but serious objections are brought against this view. One was based by M. Broca on certain features of the pla-

centa, indicating a violent separation in this important characteristic of the lemurs from the other primates. M. Vogt, while not attaching so great importance to this feature as M. Broca, brought other objections, based on diversities in the formation and connections of the jaw-bones, the structure of the orbits, the position of the os lacrymalis, the bare cerebellum of the lemurs, the shape of the uterus, the presence of inguinal mammæ in addition to the pectoral mammæ, and other points. Hence he concluded that there was no relation between the prosimians and the apes, and consequently none with man; and that, except the opposable thumbs, which occur also with the marsupials, the prosimians have no anatomical character in common with the monkeys. "Therefore it would be derogatory to all the principles of positive science to rank the prosimians among the probable ancestors of the human race." These objections are certainly important from the morphological point of view, but they do not oblige us to reject the lemurs from the order of primates. None of these divergent characteristics are contradictory of the idea that they are the first draught, the beginning, of the latter order. The characteristics drawn from the nails and the opposable thumbs press the others out of the view of the general idea which has directed the choice of the word primates.

The lemurs are the lowest family in the order of primates, and are further removed from the other families than the latter are from one another. The distance from the anthropoids to man is quite as great, as I have demonstrated in previous lectures, on the evidence of the volume of the brain and the cranial characters which proceed from it; and yet I class man among the primates. In strictness we might detach the lemurs and make a special order of them, the genealogical relation of which with the monkeys would not be thus prejudiced; but then we should be obliged to do the same with man. M. Vogt is, nevertheless, not consistent, and retains the word prosimians as the synonym of lemurs.

I have already insisted, in previous lectures, upon the relations of the lemurs with the marsupials, and more particularly with the phalangers. The insectivora come next in order. All authors, from Cuvier to M. Vogt, have mentioned the resemblance between the teeth of lemurs and those of insect-eaters. Their teeth, says Cuvier, arranging his orders downward, from man to the lower mammals, "begin to exhibit sharp tubercles gearing into one another as in the insectivora." "The Galegos," we find a little further on, "have the insectivorous teeth and regimen of the other lemurs. M. Vogt says that the dentition of the tarsiers is like that of the insectivora; and Prof. Huxley observes that the lobes of the molars are habitually very far in front, as in the insectivora. Gratiolet classed the lemurs with the insectivora. Deriva-

tion from the insectivora is, however, in no way contradictory with descent from the marsupials. The primitive type of the latter was insectivorous in the Triassic and Jurassic epochs.

The last relation to be considered is that with the ungulates, concerning which we have the observation of M. Albert Gaudry. "I have asked myself," he says, in his "Tertiary Fossils," "if the lemurs had not a community of origin with many of the extinct pachyderms." The resemblances between recent lemurs and the ungulates, pointed out by MM. Alphonse Milne-Edwards and Grandidier in their great work on Madagascar, lend credibility to this opinion. Two genera are conformed to the idea: *Adapis*, the Parisian species of which, derived from the gypsums of the Upper Eocene of Montmartre, was classed by Cuvier among the pachyderms, but appears, judging by the teeth, the skull, and parts of the limbs, to be only a lemur; and the *Aplelotherium*, classed by Gervais also with the pachyderms, and now recognized as a lemur. The resemblance occurs among the Eocene species of the stock of recent perissodactyli, such as the *Hyracotherium*, the *Lophiotherium*, and the *Pachynolophus*.

Mr. Cope has also discovered several species of Adapis in the United States, and confirms these resemblances. It is, however, proper to remark that the genealogy leading to man is not in question in this matter. Mr. Cope divides the American fossil lemurs into three families: the Anaptomorphs, which lead, by two branches, one to the monkeys and the other to man; the Mixodectines, the outcome of which I do not know; and the Adapides, which lead to the ungulates. The branch of the *Adapis* is, therefore, according to Mr. Cope, foreign to the branch leading to man.

We shall shortly now abandon the eighteenth stage, or the lemurs of Haeckel, to pass to the nineteenth, that of the catarrhinian apes, or rather to the monkeys as a whole.

The further I go, the more I am convinced that the anthropoids should be joined with the monkeys recognized by all under that name, and that they are only the highest family of them; and the more I am persuaded that they should be separated from man, looking at the matter from a morphological point of view, further than is admitted in a certain school; for the physiological or intellectual point of view is not for an instant discussable. The principal classifications of the primates are as follow:

Cuvier, two groups, man and the monkeys, the latter, under the name of quadrumana, being divided into apes, lemurs, and ouistitis, the first including what are called great apes or anthropoids.

Broca, in his last classification, which is only a variant of that of Linnæus—two groups: man and the anthropoids together; the monkeys, including those of the old continent or the pithecans, and those of the new continent or the cebians.

Huxley, in his last classification—three groups: man, the monkeys, and the lemurs, the monkeys being divided into the catarrhinians, platyrrhinians, and arctopithecans; and the catarrhinians subdivided into the anthropomorphous and the cynomorphous apes.

Vogt, in his "Mammalia"—first group, man, which we mention here, but which is not treated of; second group, the monkeys of the old continent, divided into anthropomorphous or tailless monkeys, and monkeys with tails; third group, the monkeys of the new continent, divided into platyrrhinians and arctopithecoids; and fourth group, the lemurs or prosimians.

From this we see that, with the exception of Broca, all these authors agree in uniting the great apes or anthropoids under the term apes, or catarrhinian apes, or apes of the old continent; and that Huxley and Vogt agree with Cuvier. Broca, too, may not be so isolated as I have represented him. We should recollect that he never formulated his division as above, but that it is the incontestable result of his teachings, and especially of those of his later years.

I have been led by my own studies, and resting on the differences that appear between man and the monkeys, great and small, drawn from the volume of the brain, the cranial characteristics which are the consequences of it, the facial traits that accompany it, and the characters of the skeleton which are developed in a parallel way—that is, from all the characteristics which I have especially studied—to abandon the classification of Linnæus and take up the one so much decried of Cuvier, against which no serious reproach has been brought except that of the use of the word quadrumanous and the narrow definition of the hand on which its rests. Cuvier may not have been much of a philosopher, but he was first among observers.

When Broca contested the application of the denomination quadrumanous to the monkeys to distinguish them from man, bimanous, he rested on the fact that the presence or absence of the thumb is not enough to authorize the names of hand and foot; that in man, every superior member concurs in the function of prehension, of which the extremity of the member is the immediate organ, while in the inferior member everything is organized with a view to the functions of locomotion and support which the extremity only seems destined to fulfill; in short, that there is a solidarity between all the parts of either limb, the various details of which constitute the characteristics of the functions of hand and foot. This is admirably true, as to man, at the summit of the evolutionary series of which he is the crowning. It ought to be true, too, when we descend the course of the series.

The fore-limbs of the monkeys are indeed adapted to the func-

tion of prehension, but they are at the same time organs of locomotion; the hinder limbs are also adapted to walking, but they are at the same time organs of prehension. With the lemurs there are also the same general types of all the limbs, for prehension in front, for walking behind, but the fore extremity is in fact more a paw, and the hinder one more a hand by comparison; witness, for example, the *Cheiromys*. Other monkeys are as quadrupedal as they are quadrumanous. Consider the three upper segments of each limb: there are indeed an arm in front and a leg behind; but look only at the last segment, and it will be found to be, in front as well as behind, a hand in its principal characteristics, the separated and opposable thumb, and the nails.

With man, the harmony is perfect, because the functions are specialized, and the organs are all adapted in the same respective directions, the fore ones for prehension, the hinder ones for walking. Beyond our branch of the primates, looking toward its origin, the four limbs all exhibit themselves with the same types, but less affirmed, less precise: all four for prehension, the fore ones more so; all four for walking, the hinder ones more so. The evolution begins after the train of the marsupials, and specializations are made in different directions. With some, as the galeopitheci and the cheiropters, the particular adaptation took the direction of flight; a part or all of the limb was not transformed, but bent itself to what was required, was obedient to solicitations. With others, as the ungulates, the adaptation took the direction of an exclusive locomotion upon all four limbs. These became gradually modeled upon the same type, the useless bones disappeared or were fused, and some superfluous motions ceased, while others became accentuated, and the necessary corresponding anatomical dispositions with them. With others, as the carnivora, which were to run on the ground to reach their prey, while they must be able at the same time to seize, hold, and tear it, the four paws remained perfect locomotor organs, but at the same time also organs of attack by their claws, and to a certain measure, particularly in the fore extremities, organs of prehension. An adaptation of another kind was produced with the monkeys. The animals from which they sprung dwelt in trees and ran along the branches. They needed to increase their power of prehension, they had to clasp the rounded trunks of trees, to hook on to branches in passing from one to another. The adaptation seems to have appeared first in the hinder limbs, and then in the fore-limbs. The whole of the limb did not have to lose its peculiar type for that; but it was enough if the extremities were in some way fitted to it. Nature was contented with nails, separated and opposable thumbs, and more flexible fingers, without going up to the next segment.

One fine day a revolution was effected. Just as an adaptation to arboreal life was produced at the expense of anterior species, an adaptation to terrestrial life was made, with a bipedal attitude favorable to a more extended vision, a diminution of the olfactory sense and of the facial prominence, a more perfect touch, and intelligence. Henceforth, all the living forces of adaptation tended toward the same end; the hind-thumb ceased to be opposable, the other toes diminished in length; what the feet lost the hands gained, and man was created, exclusively bimanous in front, exclusively bipedal behind, and all the accessory parts in the segments of the limbs confirming themselves in the types, less accented till now, which they had presented since the marsupials.

The peculiarity set forth by Cuvier of the opposable thumb perfectly characterizes what there is common and special among all the apes, the faculty of clinging to trees with the four extremities. It is true that this expresses only one of the details of that whole, perfect in man, which has given birth to the words hand and foot, but it is the essential one. It can not, however, be denied that the second characteristic necessary to the function of prehension—great mobility in every direction of the segments of the limb—is not very greatly developed in the hind-limbs of monkeys. Cuvier had, then, a perfect right to call all the monkeys quadrumana, although they were at the same time quadrupedal, and to oppose them to man. I, then, put the anthropoids and ordinary monkeys together under the name of monkeys, and will not recoil from the synonym of quadrumana if the term monkey does not suffice me.

The monkeys are divided into two groups, those of the old continent, also called catarrhinians, because their nostril-partitions are narrow and their nostrils are open below the nose (from κατα, low, and ῥιν, nose); and those of the new continent, also called platyrrhinians, because their nostril-partitions are broad, and their nostrils open on the side (from πλατύς, flat). The monkeys of the new continent are predominantly tree-dwellers, and are divided into two families—the monkeys proper of this continent, and the arctopitheci. The former are in turn divided into the diurnal—the howlers, the ateli, the sajous, etc.; and the nocturnal, including the sagoins, sakis, nyctipitheci, and the saimiris.

The arctopitheci or hapales are a group apart among monkeys, including the interesting wistit and the tamarin. They are tree-dwellers like the former group, and nocturnal like the latter. They afford an example of the imperfection of our modes of classification. They are monkeys, American monkeys, in many of their relations; but they lack the single characteristic that distinguishes all the monkeys, including the lemurs, and have the dentition neither of the American monkeys nor of the monkeys of

the Old Continent. We have removed the galeopitheci from the lemurs on account of the absence of the first character. Must we also remove the arctopitheci from the monkeys? Let us look at their characteristics. When we take hold of their skull in such a way as to hide the lower part of the face, they look exactly like American monkeys. Like the American monkeys, they have a round head, flat face, lateral nostrils, no gluteal callosities, no pouches. But they have not opposable thumbs, either in the fore or hind limbs, and this deprives them of the single characteristic common to all the monkeys and false monkeys. Further, they have claws on all the fingers, except on the hind-thumbs, which alone have nails. They have thirty-two teeth, the same number as the monkeys of the Old Continent and man, but with a different formula—one little molar more and one large molar less. Further, their teeth have some insectivorous characters; the lower canine is small, the molars work a little into one another like those of insectivora, and some, the forward ones, have sharp, conical points. The lower incisors of some species are pointed. Cuvier hesitated to put them among the quadrumana. For our own part, we readily see in them a step toward the primates, a kind of American lemur, a transition from the insectivora to the monkeys of the New Continent.

Fossil monkeys have been found in America, and it is remarkable that they all have thirty-six teeth, and relate themselves to the types of that continent as if the platyrrhinians had always lived there. The highest among them is the *Laopithecus*, which can be compared to the anthropoids of the eastern continent. In short, we are introduced in America to a special series, constituted, from its origin to its end, thus: Some insectivora; arctopitheci; nocturnal monkeys, beginning with the saimiris; diurnal monkeys; *Laopithecus*. MM. Vogt, Schmidt, and Cope accept this insectivorous origin.

The monkeys of the old continent are less tree-dwelling than those of the new continent, and are all diurnal. Most of them have pouches and gluteal callosities. Their teeth are generally less omnivorous than those of man, and tend, especially by the canines, to the carnivorous type, and are also less continuous. They are divided into the great monkeys, tailless monkeys or anthropoids, and tailed monkeys, which are again divided into semnopitheci, cercopitheci, and cynocephaluses. The semnopitheci (from σεμνός, venerable) include the entellus, the sacred monkey of India, a prominent figure in the Aryan legends, and the colobus of Abyssinia and Guinea. The cercopitheci include the guenon, which is found only in Africa; the magot, which lives in Africa and as far north as the rock of Gibraltar; and the macacus, which occurs in India and Japan. The cynocephaluses are large monk-

eys with a dog's snout, of which numerous species inhabit the most of Africa.

The Old World monkeys are related on one side to the lemurs, and on the other side to the ungulates. The former relationship is clearly admitted by Prof. Haeckel and Mr. Cope. M. Haeckel's argument, which is based chiefly on the conformation of the placenta, does not carry a strong conviction. Mr. Cope's rests chiefly on the conformation of the teeth, and is more solid. Mr. Huxley does not say that the monkeys are descended from the lemurs, but his descriptions suggest it. M. Vogt, as we have seen, rejects this genealogy, as also does M. Schmidt. The relationship with the ungulates is admitted by M. Gaudry, and is a consequence of the one that he has determined between the lemurs and the ungulates. In general, the *Adapis* and the *Aplelotherium* establish the communication on the former side, the point of junction being at the Eocene origin of the perissodactylic branch of the ungulates. On the latter side we have only one genus still known, the *Oreopithecus* of Gervais, which in dentition resembles the *Chæropotamus*, a genus of the *Suidæ*, or the artiodactylic branch of the ungulates. In return, there are genera of the ungulates belonging to the same stock of the *Suidæ*, or one nearly allied to it, which have marked resemblances with the monkeys. These are the *Cebochærus*, or hog-monkey, of Gervais, the *Acotherulum*, and the *Hyracotherium* of Owen. It is also to be remarked that in his general demonstration of the relation of the preceding species with the ungulates, M. Gaudry does not separate the lemurs from the monkeys, as if, from the paleontological point of view—that is, in the ancient species—the two were confounded.

Assuredly this is a very slight basis on which to found a derivation of the monkeys, and ultimately of man, from the ungulates. Yet the hypothesis has been heard; M. Vogt seems disposed to accept it, and M. Schmidt concludes a chapter in his book with the words: "The monkeys have had a very distinct double origin; the American branch had ancestors of insectivorous forms, and the Europo-Asiatic branch, including the anthropomorphs, ancestors with pachydermatous forms. We are thus near the question of the pachydermatic origin of our own primitive ancestors."

If this be so, the catarrhinian monkeys are dispossessed of their filiation with the lemurs. I confess I can not make up my mind to accept this idea. The lemurs are to me primates, quadrumana, the lowest of the order, and as such the ones which have all the chances of having engendered the others. The theory of the descent of man from the hog does not seduce me.

I am an anatomist and craniologist, and will allow no one to cast doubt on the importance which I attach to the smallest mor-

phological feature; but I ask, if over and above the details of the conformation of the teeth, fingers, and toes, the tarsus and carpus, above the characters that reflect the exact kind of alimentation, the precise method of locomotion, there is not something more general, answering to special habits, to more or less aërian, terrestrial, aquatic, diurnal, or nocturnal ways of life or abode, which impresses on the totality of the organism that general family resemblance which the naturalist recognizes outside of all those special modes of adaptation, which he studies with so much care to find in it a testimony, an expression, a formula in support of his thought and vision. A particular trait, a progressive variation of form, it is evident, reflects in general the elevated influence to which I allude. The teeth, the condyle of the jaw and its articular cavity, the temporal fosses, express quite exactly the regimen of the animal, and consequently some of its habits. The patagium, of which some traces have been observed among the petaurite marsupials, permits us to establish a series leading to the bats and passing by the galeopitheci. The genealogy of the perissodactyli, one of the most satisfactory that science has determined, rests essentially on a single character, the number and degree of atrophy of the fingers or toes.

But is the chosen form of character all? Has not nature different ways of reaching the same end, and can it not distribute its influence over the whole of the organism without making any of the characteristics particularly distinctive, and even while leaving present seemingly contradictory ones? The mouse is recognized everywhere by its attitude, its walk, its head, and its general shape, and still is found under different names among the aplacental and the placental orders, with the rodents and with the insectivora, terrestrial, half-aquatic, half-flying, and flying. The same is the case with the genus squirrel, which is scattered, with changed names, among several orders, being simply modified in some peculiarity. There is a group of most remarkable leaping animals among the marsupials, which, while preserving its type, is distributed, according as it acquires certain new characters, among various placental orders.

I ask, then, if the peculiar bearings of the monkeys, if their habitat, exclusively in trees among their most pronounced representatives, which impresses a special stamp on the whole individual; if the proportions of their body, the extent and situation of the articular surfaces and the consequent mobility of the segments upon one another, do not furnish a sufficient motive for establishing their relationship with the lemurs, and not with the ungulates? Likewise the lemurs, which lead a similar life, conduct to the marsupials, which also constantly inhabit trees. Between the ungulates and the monkeys I see nothing common of

the same kind. I can not imagine an animal with hoofs, walking only on the ends of its toes, having metatarsi joined, lengthened, and raised up, with the four limbs brought close to the body, and moving nearly always in the same parallel plane—that is, adapted to a terrestrial, measured, and rhythmical locomotion—giving birth to an animal with nails, plantigrade, having movable fingers made to fit themselves around trees, to hook on to branches, with limbs endowed with the most unrestricted movements of abduction and adduction. But it requires no mental effort to conceive an adaptation already begun in this direction with the lemurs, and having only to continue and specialize itself still further in the monkeys.

BIRD COURTS OF JUSTICE.

SEVERAL writers have given descriptions of proceedings of assemblies of birds of various species which they regarded as formal "trials in court." While this view of the nature of the transactions noticed can not yet be accepted as established by competent observation, they are certainly of an interesting character, and reveal a peculiar phase of bird-life. Dr. Edmondson describes regular assemblies of crows of the hooded species—"crow-courts" they are called—which are held at certain intervals in the Shetland Isles. A particular hill or field suitable for the business is selected, but nothing is done till all are ready, and consequently the earlier comers have sometimes to wait for a day or two till the others arrive. When all have come, the court opens in a formal manner, and the presumed criminals are arraigned at the bar. A general croaking and clamor are raised by the assembly, and judgment is delivered, apparently, by the whole court. As soon as the sentence is given, the entire assemblage, "judges, barristers, ushers, audience and all, fall upon the two or three prisoners at the bar, and beat them till they kill them." As soon as the execution is over, the court breaks up, and all its members disperse quietly.

The Rev. Dr. J. Edmund Cox has given the particulars of a trial by rooks which he witnessed between fifty and sixty years ago. He was riding along a quiet road in the vicinity of Norwich, England, when he was startled by sounds of an extraordinary commotion among the inhabitants of an adjacent rookery. Securing his horse to a gate, he cautiously crawled for a hundred feet or so, to a gap in the hedge of a grass-field, to investigate proceedings. A trial by jury was seemingly going on. The criminal rook "at first appeared very perky and jaunty, although encircled by about forty or fifty of an evidently indignant sable fraternity, and as-

sailed by the incessantly vehement cawing of an outer ring, consisting of many hundreds, each and all showing even greater indignation than was manifested by the more select number." Even the scouts, although hovering about in all directions, were so deeply absorbed in the proceedings that they failed to notice their uninvited spectator. After a short time, the manner of the accused was seen suddenly and completely to change: his head bowed, his wings drooped, and he cawed faintly, as if imploring mercy. The inner circle closed in upon him and pecked him to pieces in a few moments, leaving nothing but a mangled carcass. The whole assembly then set up a tremendous screaming and dispersed; some seeking the adjacent rookery, but the greater number flying away across the fields. It is commonly known that rooks are addicted to pilfering, and that if the robbery is detected the offender is punished. It has been noticed that young rooks will often pilfer twigs or other useful materials from the nests of their elders, with which to build their own domiciles quickly; and although they are too cunning to be caught in the act, only committing their thefts when both the owners of the nest are absent, the robbery seems always to get known. When the crime has been discovered and proved, eight or ten rooks are apparently deputed to act on behalf of the whole community; they proceed to the convicts' nest, and in a few moments scatter it to the winds.

An Alpine tourist relates that, during an excursion in the Swiss mountains, he accidentally came upon a small secluded glen, which was surrounded by trees, and became the unexpected witness of a singular spectacle. About sixty or seventy ravens were ranged in a ring round one of their fellows, evidently reputed a culprit, and, with much clatter of tongues and wings, were engaged in discussing his alleged delinquencies. At intervals they paused in their debate, in order to permit the accused to reply, which he did most vociferously and with intense energy; but all his expostulations were speedily drowned in a deafening chorus of dissent. Eventually, the court appears to have arrived at the unanimous conclusion that the felon had utterly failed to exculpate himself; and they suddenly flew at him from all sides, and tore him to pieces with their powerful beaks. Having executed their sentence, they speedily disappeared.

Sparrows also are said to hold judicial inquiry into the conduct of, and mete out punishment to, their fellow-sparrows, but without the formalities which the rooks seem to observe. When a misdeed has been brought home to any one of their community, a force of four or more sparrows is deputed to carry out the execution of the verdict. In their hurry to discharge the decree, they all tumble over one another with the greatest pugnacity,

uttering a violent clamor. The castigation is soon over, and "the unfortunate sufferer having endured the penalty," says Mr. G. Garratt, in his "Marvels of Instinct," "is as well received afterward by the community as if it had committed no transgression at all."

Mr. Garratt repeats the following story from Father Bougeant: "A sparrow, finding a nest that a martin had just built, possessed himself of it. The martin, seeing the usurper in her house, called for help to expel him. A thousand martins came full speed, and attacked the sparrow; but the latter being covered on every side, and presenting only his large beak at the entrance of the nest, was invulnerable, and made the boldest of them that dared approach him repent of their temerity. After a quarter of an hour's combat, all the martins disappeared. The sparrow thought he had got the better, and the spectators judged that the martins had abandoned their undertaking. Not in the least. They immediately returned to the charge; and each of them having procured a little of that tempered earth with which they make their nests, they all at once fell upon the sparrow, and inclosed him in the nest to perish there, though they could not drive him thence."

Another equally tragic story is recorded by the Rev. G. Gogerly in "The Pioneers," his narrative of the Bengal mission: "The flamingo," he remarks, "is common in the low, marshy lands of Bengal. My friend Mr. Lacroix—the well-known missionary—when once sailing in his boat up the Hooghly, went on shore. His attention was shortly directed to a large gathering of these peculiar-looking birds in a field some little distance off. Knowing their timid character, he approached as near as he could without being observed or exciting alarm; and, hiding himself behind a tree, noticed all their proceedings, which were of a most remarkable character. After a great deal of noisy clamor, they formed themselves into a circle, in the center of which one of their number was left standing alone. Again there was a considerable amount of screeching bird oratory, when suddenly all the birds flew on the unhappy solitary one and literally tore him to pieces." The conclusion to which Mr. Lacroix came to was, that one of these flamingos had committed an offense against the rules of their order, that he had been tried by a kind of court-martial, was found guilty, and had been adjudged, and met with, immediate punishment.

The following stories concerning storks seem to indicate that they have views concerning the purity of their race, and act upon them: Bishop Stanley relates that a French surgeon at Smyrna, being unable to procure a stork, on account of the great veneration entertained for them by the Turks, purloined all the eggs

from a stork's nest, and replaced them with hens' eggs. Ultimately, chickens were hatched, greatly to the surprise of the storks. The male stork speedily disappeared, and was not seen for two or three days, when he returned with a large number of other storks, who assembled in a circle in the town, without paying any attention to the numerous spectators their proceedings attracted. The female stork was brought into the midst of the circle, and, after some discussion, was attacked by the whole flock and torn to pieces. The assemblage then dispersed, and the nest was left tenantless.

A somewhat similar case has been cited by the same author as having occurred in the vicinity of Berlin. Two storks made their nest on one of the chimneys of a mansion; and the owner of the house inspecting it, found in it an egg, which he replaced by one belonging to a goose. The storks did not appear to notice the change until the egg was hatched, when the male bird rose from the nest, and, after flying around it several times with loud screams, disappeared. For some days the female bird continued to tend the changeling without interruption; but on the morning of the fourth the inmates of the house were disturbed by loud cries in a field fronting it. The noise proceeded from nearly five hundred storks standing in a compact body listening, apparently, to the harangue of a solitary bird about twenty yards off. When this bird had concluded its address, it retired, and another took its place and addressed the meeting in a similar manner. These proceedings were continued by a succession of birds until eleven in the forenoon, when the whole court arose simultaneously into the air, uttering dismal cries. All this time the female had remained in her nest, but in evident fear. When the meeting broke up, all the storks flew toward her, headed by one—supposed to be the offended husband—who struck her violently three or four times, knocking her out of the nest. The unfortunate stork made no effort to defend herself, and was speedily destroyed by the troop, who also annihilated the hapless gosling, and left not a fragment of the contaminated nest.

The Rev. F. O. Morris, in his anecdotes of "Animal Sagacity," cites the following instance of a case which ended less tragically: "Some hens' eggs," he says, "were placed in a stork's nest, and the others removed. The female, not aware of the change, sat patiently the appointed number of days, till the shells were broken and the young chickens made their appearance. No sooner were they seen by the old birds, than they testified their surprise by harsh notes and fierce looks; and, after a short pause, they jointly fell upon the unfortunate chickens and pecked them to pieces, as if conscious of the disgrace which might be supposed to attach to a dishonored nest."

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A singular case of almost poetic justice among storks is noticed even in so old a work as Goldsmith's "Natural History," into which it was imported from Mrs. Starke's "Letters on Italy." "A wild stork," runs the tale, "was brought by a farmer in the neighborhood of Hamburg into his poultry-yard, to be the companion of a tame one he had long kept there; but the tame stork, disliking a rival, fell upon the poor stranger, and beat him so unmercifully that he was compelled to take wing, and escaped with difficulty. About four months afterward, however, the latter returned to the poultry-yard, in company with three other storks, who no sooner alighted, than they fell upon the tame stork and killed him."

SKETCH OF J. B. BOUSSINGAULT.

BOUSSINGAULT, says M. P. P. Dehérain, "by applying the rigorous processes of analytical chemistry to the study of agricultural questions, laid the foundations of a new science on solid ground. When he began, agricultural chemistry was still groping in infantile efforts. . . . At the end of his long life he was able to see the processes of investigation which he had devised employed everywhere; his ideas, tested by thousands of experiments, taught in all the schools; and agricultural science sure enough of itself to guide those who were practicing it and lead them to success." M. E. Tisserand says that "the influence of his labors and publications upon agriculture was immense, and that they were the real point of departure of the great scientific agricultural movement which has been executed during the last forty years." We find his life, as we review it, for one who was so great in works wholly of the laboratory and the farm, to have been unusually full of incident and adventure.

JEAN BAPTISTE JOSEPH DIEUDONNÉ BOUSSINGAULT was born in Paris, February 2, 1802, and died on the 11th of May, 1887. His father, a modest tradesman, sent him to the classical course of the Collége Louis le Grand, without any particular thought of directing him to science; but one of his comrades introduced him to the laboratory of Thénard at the Sorbonne, and he was strongly attracted toward chemistry. He became a frequent attendant at the scientific courses, and was accustomed to repeat at home the experiments with which he had been most struck. Classical studies no longer interesting him, he left the college and attached himself to the lecture-classes of Thénard, Biot, Gay-Lussac, and Cuvier. At eighteen years of age he entered the School of Mines at Saint-Etienne, whence he was graduated an engineer in 1822. He had already published in 1820 a memoir on platinum silicide,

which was marked by sagacity and precision, a work which he was destined to resume and complete fifty-six years afterward, without modifying his first conclusions.

In his twentieth year, and when he was full of ardor in the pursuit of science, and thirsting for the glory of conquering in new fields of investigation, and at the very time, it seems, when he was contemplating a journey to Asia, he received a proposition from an English company to go to South America, to recover some old mines that had been abandoned for many years and resume the working of them. A scheme had also been broached for founding at Bogotá a school of mines like that at Saint-Etienne; and as there were explorations to be made in the volcanic districts, and the observations and determinations that had been begun by Humboldt to be carried on, Boussingault accepted the mission with its tempting prospects of further scientific work. In preparation for it, he doubled his diligence at the Sorbonne and the Museum, took lessons from Arago in the management of instruments of observation, and obtained letters of introduction from Humboldt. He took passage in September, 1822, in an American brig of eighteen guns, which did not succeed in making the landing at Laguayra without having "a brush" with a Spanish frigate.

Boussingault found the country in the midst of the revolution against Spanish rule. Bolivar had united Venezuela and New Granada into the Republic of Colombia, and had propagated the insurrectionary movement into Peru. The circumstances were hardly favorable for the prosecution of the peaceful work he had marked out. He sought Bolivar in his camp, to consult with him concerning the course he should pursue. The interview was rudely interrupted by a fusillade; it was, however, only a picket-skirmish, and the Liberator, resuming the conversation, remarked: "You will observe, sir, that you have come to a country where the miner's pick is less used than the soldier's musket; it is easier for me to give you an officer's commission than an engineer's license." Boussingault accepted the office of lieutenant-colonel.

Boussingault spent ten years in South America, making use of every opportunity to study the grand phenomena in which that region is so rich, and reaped as the fruit of his sojourn an abundant harvest of observations in many departments of science. His work included numerous mineral analyses; the discovery of a new mineral, which he named, after one of his teachers, Gay-Lussite; analyses of the milk of the "cow-tree," of palm-wax, of guanos, and of the thermal waters of Venezuela; and the discovery in the province of Antioquia of a bed of platinum, a metal which had previously been known only as it was disseminated in sands. He often made his analyses of minerals on horseback, with the aid of a portable balance; he carried a Fortin barometer slung over his

shoulder, with which he estimated the height of mountains. His methods of investigation were sometimes extraordinarily ingenious. In taking the temperature, for instance, in the crater of Pasto, having found his thermometer inadequate, he let down some of the tin-foil wrappings of his chocolate-cakes. The tin was melted. The temperature was therefore higher than the melting-point of that metal, or more than 235° C. He then let down a pistol-ball, which was not melted. The temperature was thus found to be lower than the melting-point of lead, or less than 332° C., and was therefore somewhere between the two extremes. The guide who accompanied him on this adventure could not conceal his nervousness at hearing the subterranean roarings of the volcano, and, looking into the crater, asked, "What if it should burst out?" "Then we should be lost," replied Boussingault. The guide answered, calmed by the coolness of his superior, "That is what I think too." In 1831 he accomplished the ascent of Chimborazo, which Humboldt had been obliged to give up, with the loss of one of his instruments—and recovered the instrument. Boussingault had many stories of his adventures in the South American wilds, which he used to tell with much enjoyment, and which his friends found very entertaining. During his travels on the pampas he was attended by an Indian, who cared for him as if he had been a child. He having been attacked by a violent fever, the Indian saved his life by himself chewing the proper food for his helpless patient and putting it into his mouth. On these plains Boussingault made his investigations of curare and other poisons, and of the properties of coca. He witnessed a number of earthquakes. On one such occasion he was obliged to drag out by the feet some unfortunate persons, who had prostrated themselves in front of a church in prayer, to save them from being crushed by the falling building. The stupefied natives made loud confessions of their sins, concerning which the chemist used to remark, when telling of them in after-years, that he heard some most curious stories.

Boussingault returned to France in 1833, having gained a hhig scientific reputation. The numerous contributions which he had sent to the Academy, says M. Dehérain, had revealed in him a sagacious and intrepid observer, knowing how to see well, and endowed with a broad critical sense. He was immediately appointed Professor of Chemistry in the Scientific Faculty at Lyons, then made dean of the faculty in 1837, Thénard's successor at the Sorbonne, and afterward professor in the *Conservatoire des Arts et Métiers* in Paris—an office which he held titularly till the end of his life, while he retired from active work in it in 1875, and was succeeded by M. Schloesing.

M. Boussingault's career was diversified by a short period—

from 1848 to 1851—of political service, in which he represented the department of the Lower Rhine in the Constituent Assembly, and was nominated Councilor of State. He discharged the duties of these offices—which he had accepted from motives of patriotism alone—while, his political activity being regarded as merely temporary and for an emergency, his professorship at the Conservatory was kept open for him. Having bade a final good-by to politics in December, 1851, he used afterward to say, "There are few men of science who have succeeded in it, and science has always lost by it." But he always followed political events with a lively interest. Although his liberal and republican opinions were subjected to more than one blow from the events which were enacted in France, he did not consider it his duty to refuse the distinctions which were addressed to the man of science; and, while he held himself apart from the official world, he had occasion to give Napoleon III some good advice—which was not followed—concerning the expedition to Mexico. By his marriage, in 1833, with Mlle. Le Bel, an Alsacian heiress, M. Boussingault became joint proprietor, with his brother-in-law, of the fine estate of Bechelbronn, in the Lower Rhine. The cultivation of this farm afforded excellent opportunities for experiments on the applications of chemistry to agriculture, concerning which it also suggested many questions; and the skill which had been cultivated and so creditably employed among the volcanoes and in the pampas of South America, now found a more practical field for its exercise in the investigation of matters which touched the vital interests of the nation, and, individually, of a large proportion of its members. These investigations laid the foundation of the science of agricultural chemistry as it is studied and practiced to-day; and Boussingault's French friends claim, not without reason, that his Bechelbronn farm was the prototype of the farm at Rothamsted, in England, and furnished the model after which the German laboratories for agricultural investigation were planned.

M. Boussingault's greatest scientific work, that for which he was most famous, was connected with his experiments upon the value of food-rations and the influence of various chemical agents upon the growth of plants; and those to ascertain whence plants derive their constituent elements. When he began them very little was definitely known on these subjects; even the composition of hay was not correctly understood. It was not his privilege to carry these inquiries to a complete result; but he made the initiatory intelligent efforts toward solving them, set the work well afoot, and pointed out to those who are still seeking with accumulated skill and intelligence the way which they should pursue. "The processes," says M. Dehérain, "for the estimation of carbon, hydrogen, and nitrogen had been made effective; the methods

were still laborious, but sure; M. Boussingault employed them, and in a few years succeeded in, to a large extent, sketching the great work which is still being prosecuted, without in any way changing the programme which the masters had laid out nearly fifty years before. His robust good sense was not deceived. He saw how the problem could be approached with exact methods of elementary analysis. If he had tried at this time to follow in M. Chevreul's tracks and undertake the immediate analysis of agricultural products, he would have been foiled. The time had not come, and it is interesting to compare from this point of view his first experiments on germination with those which he executed forty years later, when the progress of organic chemistry had made accessible what was not within reach at the beginning." In his analysis of plant-foods and his studies of the origin of the nitrogen in herbivorous animals, the rigor of his methods was marked; his conclusions were reached slowly, not from one or a few experiments, but after a series of them. "One must know," he would say, "how to criticise himself; it is not till after he has exhausted all objections that he can estimate the value of them, and come to a conclusion." His labors were characterized rather by the clear and precise view of the end to be reached, abundance of observed facts, and lucidity of demonstration, than by ingenuity of methods. It was only rarely that he permitted himself to indulge in those bold and specious generalizations which are so pleasing to many and are so quickly forgotten; and before the end of his life he was cured of all disposition toward them. "Skepticism, even a little harsh in regard to the labors of others, had become habitual with him."

With such slow deliberation and painstaking care he pursued through more than thirty years, in his laboratory and upon his farm at Bechelbronn, his experiments on the composition of plants and their parts; of soils and manures; the effects of different soils and different manures, of no soil (or only sand or gravel) and no manure, of air as it exists and of air purified of all foreign elements, upon the growth of plants; varying the experiments in every conceivable way, year after year, testing them one by another, and comparing them one with another—all for the double purposes of learning whence plants derive their nitrogen, and what are the best kind and form of fertilizing material for each plant and for each kind and condition of soil. The first question is still not solved. On the other side, the investigations have contributed greatly to the improvement of agricultural methods and to the rewards of wise cultivation. The results of these studies are embodied in the "Rural Economy" and the "Agronomy," and in such papers in the journals of scientific societies as those on "The Estimation of Ammonia in Waters"; on "The Quantity of Am-

monia contained in the Rain, Snow, Dew, and Fog collected at Liebfrauenberg"; on "The Method of Estimation of Nitric Acid in Presence of Organic Matters"; on "The Quantity of Nitric Acid contained in Rain, Fog, and Dew"; on "The Influence of Vegetable Mold on the Nitrification of Organic Nitrogenous Matter used as Manure"; on the inquiry "Whether Nitrogen is emitted during the Decomposition of Carbonic Acid by Leaves"; on "The Relation between the Volume of Acid decomposed and that of Freed Oxygen"; and many others. "He verified," says M. Tissandier, "the fact, only half seen by his predecessors, that plants fix the carbon contained in the carbonic acid of the air; he also proved definitely that plants decompose water to appropriate its hydrogen to themselves. He determined that plants derive nitrogen from the soil, and that, according to Lavoisier, in the vegetable kingdom as in the laboratory, 'nothing is created, nothing lost.' What is put into the soil as manure appears again in the plant as the crop." "Undoubtedly," says M. Dehérain, "the services which he has rendered to agricultural science by demonstrating the intervention of combined nitrogen in animal or vegetable nutrition are immense. The estimation of the value of rations and of manures rests upon principles that he has laid down; but whatever admiration we may feel for this part of his work, however great may be its practical utility, M. Boussingault has left it unfinished, and has never pointed out how atmospheric nitrogen is drawn into the movement of life."

M. Boussingault's eldest daughter having been married to a son of Jacob Holtzer, proprietor of extensive iron-works on the Loire, his son-in-law built him a spacious laboratory at the shops. Having been driven from Alsace by the Franco-German War, he afterward spent a considerable part of the year at this place, where he made his studies upon iron and steel. M. Boussingault published a memoir on the extraction of oxygen from the atmosphere by means of baryta, and conducted an investigation, with M. Dumas, of the proportions in which the constituents of the atmosphere are mingled. His "Rural Economy" was published in 1844, and an English translation in 1845. Revised and enlarged, and embodying the fruit of years of additional experiments, it was given forth in a new form, in 1861–'64, as "Agronomie, Chimie Agricole, et Physiologie," in three volumes. M. Boussingault was made a grand officer of the Legion of Honor in 1876. He received the Thénard medal of the "Société d'Encouragement" in 1872, and the Copley medal of the Royal Society of England in 1878. These medals he kept very carefully, along with the more modest medal which Bolivar had given him on their parting, and of which he thought more than of either of the others, for it was associated with the bright days of the South American life of his youth.

CORRESPONDENCE.

WOMEN IN BUSINESS.

Editor Popular Science Monthly:

I NOTICE a communication, in your July number, from Mrs. L. D. Morgan, of Baltimore, and, as it is on a subject in which all women are more or less interested, I beg the kindness of space in your columns for a reply. Mrs. Morgan opens her letter with the assertion, referring to the Women's Parliament recently held in Washington, that "one point seems to have been clearly developed, viz., that women are no nearer the ballot-box than they were fifty years ago." Fifty years ago such a gathering of women from all parts of the world as was seen at the Women's Parliament would have been utterly impossible, and had such a state of things been predicted it would have been received with as much incredulity as a prediction of the electric light or the telephone. Not only does the fact that such a gathering is now possible demonstrate that women *are* nearer the ballot-box than they were fifty years ago, but there is another fact which Mrs. Morgan seems to have entirely overlooked or forgotten, which is that in some of the States and Territories women are not only nearer but have actually reached the ballot-box, and are voting on State and municipal questions.

In the next paragraph of her letter Mrs. Morgan says: "The ladies who are acting in behalf of their sex are decidedly hasty and incautious in demanding, without limitations, equal pay for equal work. At first sight, indeed, the proposition seems a fair one," etc. Wherein or how these ladies are hasty and incautious, or wherein or how the proposition differs in appearance at second sight from what it was at first, Mrs. Morgan fails to show. Men, competing with men, demand equal pay for equal work, and why the same demand can not logically be made by women competing with men I fail to see. A little further on Mrs. Morgan says: "That a woman can acquire the routine of almost any mercantile pursuit may be admitted beyond a doubt; in fact, the quickness of her mind and her rapid if superficial grasp of a subject will give her the advantage, in many branches, over her brother workers." I respectfully ask, What is the routine of mercantile pursuits? If there is any special part or division of mercantile pursuits to which the word routine can be applied to distinguish it from any other part or division, then Mrs. Morgan may be correct, and women may have business capacity superior to men; but, until that fact is established, I will adhere to my conviction, produced by a life of work with both business men and women, that women are in no respect superior to men.

Despite of this pathetic description of "life as it is—the rough, every-day work of the world, where weakness means failure, strength success, where sentiment counts for nothing, and money is the paramount object"—I think Mrs. Morgan's knowledge of business life and business men is rather fanciful and theoretical than real. Is there not a contradiction between her assertion here that sentiment counts for nothing, and the one made a little further on in the same paragraph that "no man, who is worthy of the name, can quite bring himself to treat a woman clerk as he would a man, even in this ungallant age"? What but sentiment should prevent him from treating a woman clerk as he would a man?—the sentiment that women are made to be protected by men, and he will protect his, and those who have no protector must go unprotected. Had Mrs. Morgan's experience of business men been real instead of fanciful and theoretical, she would have known that "the employer who has expressed his disapprobation or impatience, without much regard to his p's and q's, would be much more dismayed to find he had insulted a male than he would to find he had insulted a female, as the male would in all probability resent the insult with a blow, to be followed, where the employer is anything of a politician, by his adverse ballot at the next election, while the female would have no resort except in the employer's sentiment, which, as Mrs. Morgan truly says, "counts for nothing." To discuss this part of the question, however, is mere waste of words, as the vast majority of business men, being gentlemen (a fact of which Mrs. Morgan does not seem to be aware), pay the strictest regard to their p's and q's in expressing impatience or disapprobation either to men or women.

For fear of infringing too much on your space, I will notice only one other point which Mrs. Morgan makes, on what she terms the "transitory nature of woman's work." She makes the old and oft-repeated but never proved assertion that women never remain long in any one business, for the reason that they marry, after which they retire to strictly domestic life. We have no statistics on this subject that I know of, but my personal experience goes to disprove this view of the matter. Five years ago I obtained work in an establishment where at the time were employed, besides myself, and in the same room, six men, two boys, and five women. Of these six men and two boys only one man remains, their places having in some instances been filled by men who are also gone, and have been succeeded by

others: *where they were succeeded by women, those women are there yet.* Of the five women who were there then, three remain, one having quit on account of ill health, the other for what cause I do not know. What does this record show of the "transitory nature" of woman's work as compared with man's? Mrs. Morgan might pleasantly spend her leisure time in gathering statistics on this subject in her own city; it would probably give her subject for thought, and would beyond doubt dispel her illusion that "woman is an anomaly in a business office among business men," or show her that the anomaly occurs so often that it has grown to be the rule.

Respectfully,

LUCY S. V. KING.

25 FIRST STREET, CHATTANOOGA, TENN.

POPULATION AND THE FOOD-SUPPLY.

Editor Popular Science Monthly:

IN Prof. Huxley's article, "The Struggle for Existence," he states the obvious fact that "so long as the natural man increases and multiplies without restraint, so long will peace and industry . . . necessitate a struggle for existence as sharp as any that ever went on under the *régime* of war." But this promptly suggests the important modification that all classes of men do not increase equally. "Punch's" humorous statistics a quarter of a century ago gave to the well-to-do quarters of the town an average of only half a baby to each house! More serious observation shows, from the yeast-plant up, a steadily diminishing rate of increase, pyramid-like, until the cap-stone is reached—an average human family consisting of five persons, the three children replacing the parents, with only one to spare. But the cap-stone itself diminishes to a point. The human race differs in fecundity—the worst nourished and most emotional being the most prolific, and the best fed and the best poised intellectually producing not enough to maintain their own numbers. The Dutch numbered about two millions. They created their country largely out of the ocean, and survived a mud avalanche of cruelty and brute force. In South Africa, Java, New York, and elsewhere, they have been a permanent force, as well as in science, literature, arts, and arms. But their numbers have not greatly increased. On the other hand, the natives of the south of Ireland have been decimated by famines and chronic insufficiency of food. They have founded no distinctly Irish colonies anywhere, but contented themselves with adhering closely to Anglo-Saxon communities in all parts of the world, which contact they declare to be injurious to them. It is claimed that their numbers have increased in recent times from about six millions to thirty millions, more or less. Eminent men, like George Washington, leave few or no descendants. Napoleon, as the fruit of two marriages, had one child. Hardly any of the peerages in the House of Lords, consisting of some four hundred members, are more than two hundred years old, and if, as proposed, no new peerages should be created, the hereditary legislators would become extinct—the object aimed at by the proposal. The present tendency of civilization referred to by Huxley, to sacrifice the best to the worst perpetually, would seem at first sight to reduce the whole to a dead level of the worst possible. But further reflection shows the effect to be to raise the whole mass from the bottom. If the mass can be well fed, refined, and intelligent, Nature will no longer throw off such frightful numbers of rudimentary men, but will be as niggardly of human beings as she now is chary of perpetuating great intelligences. In this direction there is hope that the problem may be solved.

The possible food-supply is encouraging. The census of 1860 showed that the maize-crop of the Mississippi Valley, if turned into its equivalents of beef and bread, would feed sixty millions of people. The food-resources of the sea have hardly been touched. All the fish known to have been caught by man's device would not make one school of the most numerous kinds. The position of the human race in regard to the visible but unavailable food-supply resembles that of hungry young children surrounded by square miles of ripe, waving grain and countless herds of beef-cattle.

S. H. MEAD.

EUSTIS, FLA.

THE EARNED DECREASE.

Editor Popular Science Monthly:

THE argument of Mr. Joel Benton, in his article in the June number of the "Monthly," on "Earned Decrease *vs.* Unearned Increment," seems to be in several places quite defective. It scarcely touches the weakest points of Mr. George's theory at all.

It is argued by Mr. Benton: "If society has a claim upon this profit" (the "unearned increment") "in the socialistic way, which George and his followers claim it has, then, to make the equities right and even, it ought to shoulder, without a whimper, the losses which have befallen the land-owners who have suffered from the 'earned decrease.'" Really, however, if the matter is looked at in the proper light, it seems that the "earned decrease" offers, so far as land in the economic sense is concerned, no complication at all. Suppose that society asserts its claim to all the land, and becomes the owner *de facto*. Then, as to subsequent gains or losses in land-values, it is plain that society must enjoy the one and suffer the other, for, wherever social aggregation should bring increased value to land, society, under the George plan, would experience the benefit through greater rents; and wherever social dispersion should lower the value of land, society would sustain the loss through decreased rents. As to pro-

vious gains or losses, there would be two cases to consider—one in which society gives compensation to private holders, and the other in which it reclaims the land by outright confiscation. In the first case it would plainly be unjust to ask society to assume the burden of any "earned decrease." Suppose, for example, that A and B each own land of which the maximum value has been one hundred dollars, and that when society, or the state, buys the land, A's is at its maximum, while B's has fallen to fifty dollars. Can B claim that he should receive as much as A because his (B's) land has once been worth as much as A's, when it is now worth to the buyer only half as much? But in the second case—where confiscation is the hypothesis—it would be clearly inconsistent in society to assume the loss of the "earned decrease." Using the same example as above, if A gets nothing, can B, whose land is worth fifty dollars less, claim that he ought to get fifty dollars because the said land has fallen that much in value? The truth is, that what Mr. Benton calls the "earned decrease" is in most cases only a reduction, according to its size, of the "unearned increment"; that the former is nearly always less than the latter, and serves only to cancel part of it. Sometimes, however, social fluctuations destroy values which have been produced by actually expended labor. This fact, it seems to me, Mr. Benton should have brought more prominently into view; it affords the best foundation for his argument.

The deduction drawn by Mr. Benton from the example which he gives to show how worthless land is in some parts of New England is a very peculiar one. He says: "A friend of mine bought a productive farm of one hundred and sixty acres in Massachusetts a few years ago, with a good house, barn, and other fixtures upon it—and he did not pay *the price that the barn alone cost*. . . . This means getting the land itself for *less than nothing*, which is on better terms than Henry George's creed calls for." Has it not occurred to Mr. Benton that his friend may have paid for the land, and got the barn and other improvements for nothing? "Surface improvements" may, and often do, become absolutely valueless; but it is hard to conceive, so long as they have not reached this condition, that the ground on which they are fixed should be worth nothing.

The statement that neither Mill nor Spencer has offered any solution of the problem of dealing with the "unearned increment" is scarcely justified by the facts. Mr. Benton should read Mill's "Principles of Political Economy" and Spencer's "Social Statics" a little more closely. In the former he may refer to Book V, Chapter II, section 5. As to the latter, I am sorry to say that I haven't the book at hand, and can not give him the exact reference, but if he will have the patience to search for it he will find that Spencer also has a plan.

GEORGE P. GARRISON.

AUSTIN, TEXAS, *July* 10, 1888.

EDITOR'S TABLE.

STATE EDUCATION IN ENGLAND.

WE ventured in our last number a few remarks on the unsatisfactory results, in this city, of the political management of education. Evidence is now forthcoming that in England the cause of popular education has been no better served by state interference than it has been in this country. A Royal Commission that was lately appointed to inquire into the condition of education in Great Britain has made its report, and in that report there occurs what we can only interpret as a distinct admission of the superiority of voluntary effort over state control in the sphere of education. The report is not in our possession, but the following quotation from it appears in an English newspaper: "If it were needful to strike a balance between the efficiency of the two systems of board and voluntary school management, the evidence would lead us to divide the honors. The system of management transacted outside the school is most vigorously conducted by the school board, dispensing the money of the rate-payers; but in the closer supervision of the school, and effective sympathy between managers and teachers, or managers and scholars, the commission pronounce in favor of the efficiency of voluntary management. In the combination of the advantages of both systems we look for progress in the future." We confess to being at a loss as to what, precisely, is meant by "the system of management transacted in-

side the school"; but it strikes us very forcibly that it must merely be a means to an end—that is to say, that it must be secondary and subsidiary to "the system of management transacted inside the school"; and if so, the conclusion is inevitable that, as regards this far more important matter, the private schools carry off the palm for efficiency. The admission is, to our mind, a very significant one. Government can do outside work, but not inside work. It can put up buildings, provide apparatus, organize a staff of superintendents and inspectors, and make a great show over examinations; but when it comes to the vital point of teaching it breaks down, or, at best, does the work inefficiently. When will people understand that government work is esentially "outside" work, and that, when they want inside work, they must do it themselves? Government has the taxing power, and can do whatever the command of money enables it to do; but, when more than this is wanted—when, for example, to quote the words of the Royal Commission, it is a matter of establishing an "effective sympathy between managers and teachers or managers and scholars"—state agency will not work.

It so happens that, almost simultaneously with the appearance of this report, a teacher of long standing and much experience, Mr. James Runciman, publishes in the "Contemporary Review" a most powerful arraignment of the whole system under which the board schools in England have been conducted since the passing of the Education Act in 1870. That act he pronounces to be "a failure, if we contrast the means expended with the total results obtained; in fact," he adds, "the powers of evil seem to be gaining force, if we study broad results." Speaking of his own career as a teacher, he says: "After bitter years of effort I saw that I was frittering away my life, and thus the gladdest day I have ever known was that on which I knew I should work under the useless pedantic code no more. Ninety-nine out of every hundred teachers in Great Britain would follow my example if they could, for there is no chance for a man or a woman to lead a *human* life, so long as the code governs them; and I say deliberately that our national millions of educational grant are mostly spent on keeping up a mischievous imposture which broods like a perpetual blight over education." "Roughly speaking," he says in a later part of the article, "we have spent fifty million pounds of money on teaching a generation how *not* to become good scholars, good workmen, good clerks, or good citizens, and we have performed that remarkable feat in order to satisfy the fantastic desires of a set of pedants whose judgment is scouted by every practical man." We quote only the conclusions arrived at and vigorously expressed by Mr. Runciman, because we have not space for the facts and illustrations by which he supports them; but all who turn to his article for themselves will see that he has not spoken without great and bitter cause.

The Royal Commission express the hope that it may be possible in the future to combine the special merits of state administration, consisting chiefly, as we have seen, in capacity for work "outside the school," with the strong points of voluntary effort. The hope is an amiable one, but we regard it as wholly illusory. The very life of education resides in the free competition of ideas, in private initiative, and in the feeling of individual responsibility. Education without these can be little more than a hollow mockery. It will be "outside" work in the worst sense; and, when we seek to gather from it those fruits of intelligence and morality which a system of national education might be supposed to yield, we shall find the tree smitten with a mysterious disease, and the half-formed fruit falling withered to the ground. "A mysterious disease," do we say? Yes, mys-

terious to those—and to-day they seem to be the multitude—who look to the Government and the Legislature for their salvation in all things; but not mysterious to those who believe that the heaping of functions on the state is the very canker-worm of liberty and progress.

THE CLEVELAND MEETING OF THE AMERICAN ASSOCIATION.

THE recent meeting of the American Association for the Advancement of Science at Cleveland appears to have been a very satisfactory one. Many circumstances seem to have contributed to its success. The weather was favorable. The members came prepared with papers which were, for the most part, either in their scientific character or their practical bearing, worthy of the name of the Association. And the place of meeting was happily chosen. It had been thirty-five years since the Association met before in Cleveland, and during the interval the city had enjoyed a tenfold growth and development, which, as President Staley pointed out in his welcoming address, was, to a large extent, owing to the advance of science and its applications in the arts and in manufactures. "It would be difficult," the speaker added, "to find a city in which a larger proportion of the inhabitants are interested, directly or indirectly, in pursuits which depend upon scientific methods and processes." The people showed, by their attendance upon the meetings, by their treatment of the members of the Association, and by the avidity with which they read the unusually full newspaper reports of the proceedings, that they appreciated and enjoyed the privilege of having such a body among them. In these points they set an example to some cities of much larger proportions and pretensions.

The wonderful achievements of science, as illustrated by the work of the Association, and the industrial development of Cleveland, were the theme of President Staley's welcoming address. The speaker happily illustrated these wonders by introducing the figure of a citizen of Cleveland, who, meeting in the East a Persian story-teller of the Arabian Nights pattern, should easily defeat him in a game of capping stories by simply relating what he saw actually going on every day in the factories and workshops of his native place. The same topic was touched upon from another direction in President Powell's opening address, in which he indicated the innumerable fields of research that were represented in the membership of the Association.

The address of retiring President Langley, which was made at the evening session of the first day, was probably suggested by his own researches, and bore upon the history of the doctrine of radiant energy; while the speaker could not prognosticate the future of this doctrine for any distance in advance, he suggested, as a problem awaiting more immediate solution, the relation between temperature and radiation. The vice-presidential addresses bore the usual relations of such papers to the special departments in which their several sections were concerned. Prof. Stone, in astronomy, discussed the confirmation which Newton's theory of gravitation had received from studies in that science. Prof. Michelson, in physics, described his experiments to devise a standard of measurement from light-waves. Prof. Monroe explained what light the investigation of chemical compounds casts upon the doctrine of evolution. Prof. Cook, in geology, insisted upon the indispensable importance of American geology to the completeness of the science, and to the construction of a systematic and adequate nomenclature. Prof. Riley, in biology, who seems to have been exceptionally happy in his audience, traced the progress and establishment of the doctrine of evolution. Dr. Abbott, in anthropology, reviewed

the evidences—largely of his own discovery—of the extreme antiquity of man in America. Prof. Smiley, in economical science, sharply criticised many modern ideas and practices in benevolence, which he described as too indiscriminate and contrary to nature. The papers in the several sections mostly illustrated the personal researches of their authors or bore upon matters of daily interest, and seem to have been peculiarly acceptable to the audiences who thronged the meetings. The Association is always happy, when it meets in the basin of the Great Lakes, in being upon a ground which is fruitful in lessons in geology, botany, and climatology, and which could of itself supply subjects for papers enough to engage the whole attention of the meeting. These subjects were well represented. Industrial or manual training was not forgotten in the Economic Section; in which also Prof. Atwater essayed to show that the increase of the human race is never destined to outrun the possibility of food-supply; and the impracticability of the Panama Canal was demonstrated for the *x*th time. In anthropology, attention was called to several antique American works the preservation of which has been secured, and to many others which ought to be taken care of; the affinities of the Aryan and other races were considered; and interest was expressed in the institution of an international language, for the purposes of which Volapük was regarded as inadequate. A report was presented by Prof. Mendenhall, from the committee on that subject, on the teaching of physics.

While the work of the meeting was nearly all of a high scientific character, it was also of such a nature or so performed as to be what the people wanted. All the vice-presidents, says one of the city papers, "were wise in placing, as far as possible, their views and theories on a plane not too scientifically lofty for the appreciative observation of those less learned than themselves." Another newspaper expression is to the effect that—

> One great fact has stood out prominently in all the work of the Association in this city, and that is the practical value of science. No matter what the subject discussed or how technical the treatment, the connection between theoretical science and applied science was plainly discernible, and should need no argument to convince an intelligent resident of Cleveland of the value of applied science, or its intimate connection with everybody's business or the general welfare.

Another lesson, which has also an important social bearing, may be drawn from the experience of the city papers. They were not afraid to give full reports of the papers read, covering from one to two pages of their daily issues, so that members of the Association said the papers of no other city had served it so well, except, *perhaps*, those of Boston. Of the results upon themselves of making the large sacrifices of space usually devoted to more sensational matter which this required, the "Plain-dealer" says:

> Those who have read the reports from day to day will admit that the space was well filled, and that the influence on our city can not but be good. Science has been brought to the doors of our people and carried by the papers into their homes, and those who hitherto paid it no attention have been compelled to take some interest in it. To the surprise of some of the—at first unwilling—readers, the topics discussed were found to concern themselves, and to be treated in an entertaining manner. Instead of skipping the proceedings in the next day's issue, they read them with increasing interest, and on the third day turned to them with as much eagerness as if the columns contained a bit of political news, a murder—or a base-ball game. The appetite grew by what it fed on, and each new paper was read with keener interest and better understanding. The effect on such readers—and they can be numbered by thousands—will be lasting. They will hereafter pay more attention to matters of scientific character, and will have a greater regard for scientists.

Are the people, are the newspapers, of Cleveland, wiser or more intelligent than those of any other city, except perhaps Boston? Or is the fact beginning

at last to appear, that those who read the newspapers and sustain them appreciate matter of solid worth, and will buy it and read it when it is offered to them?

LITERARY NOTICES.

THE ORIGIN OF FLORAL STRUCTURES THROUGH INSECT AND OTHER AGENCIES. By Rev. GEORGE HENSLOW, F. L. S. Illustrated. "International Scientific Series," Vol. LXIII. New York: D. Appleton & Co. Pp. 349. Price, $1.75.

THIS volume deals with one of the most interesting departments in the whole range of botanical science. It is, in fact, almost common ground for both the botanist and entomologist. The author accepts as a fundamental principle that environment furnishes the influence which induces plants to vary. A brief outline of the steps taken by various authorities along this line, from Geoffroy Saint-Hilaire in 1795, to Darwin of recent time and Herbert Spencer of to-day, is given in the preface.

Prof. Henslow early had his attention attracted to floral structures in their relation to insect visitors, and this volume is an elaborate treatise in which the object, in the author's own words, is to "endeavor to refer every part of the structure of flowers to some one or more definite causes arising from the environment taken in its widest sense." The early chapters deal with those elementary principles so essential to a full and accurate understanding of that which follows. Symmetry, or lack of it, is treated at length, and many causes are assigned for the disappearance of petals, stamens, etc., or their augmentation. Then follows a discussion of the principles of arrangement. The alternation of the floral whorls is, for example, considered due to their being composed of spirals "which are projected on to the same plane and so form verticils," and the position of stamens follows in consequence of the branching of fibro-vascular bundles. In some cases the sepaline bundles give rise to a whorl of stamens, and in others the petaline cord. Why this should be is not understood. Nutrition is the immediate cause, but why the nutrition should flow in one or the other direction remains obscure.

The irritation induced by insects is a potent cause of the flow of sap to certain parts, which encourages local growth and thereby brings about a union between parts of a whorl or between different whorls. Prof. Henslow's theory is therefore "that the forms and structures of flowers are the direct outcome of the responsive power of protoplasm to external stimuli." That hypertrophy results from irritation is well shown in many instances, but some persons may be slow in granting all that the author is free to ascribe to the theory. He, however, makes a strong argument, and brings forward a great array of facts. Other causes are, however, not overlooked, and hereditary influences is one of these. Irregularity in flowers is shown to be for the purpose of securing the pollination of the stigma. "All flowers, as we have them now, which are in perfect adaptation to insect agency, are the outcome of the resultant of all the forces, external and internal, which the insect has actually brought into play, or stimulated into action by visiting them for their honey or pollen." With this working theory the author is able to show good reasons for the development of flowers having a bilateral symmetry. The portions of a flower upon which insects alight have become large and strong by responding to the strain that insects have brought upon them. Subsequently hereditary influences have come into play, and now the enlarged part may be present before there is any necessity for it. At the same time compensatory degeneration goes on in other parts of the flower. In the tendency of irregular flowers to become regular under cultivation, the author recognizes negative evidence to his theory. Presuming that the irregularity was brought about by insects, the demand for irregularity under culture being wanting, the flowers revert to their ancient regular form. "Did we but know what the insects were, and how they have poised themselves upon the flower, and in what way their proboscides and tongues have irritated the different parts, one might be able to describe more accurately the whole process; but that such have been the cause and effect as above described, seems to me to be too probable a theory to be hastily discarded in the absence of a better one." The author frequently refers to such striking examples of quick response in tissues to insect irritation as are seen in the formation of galls, and he concludes that if the stimulus

were constant in any one part of a plant, in the course of time the response would become hereditary. Thus the adhesive pads of certain creepers (*Ampelopsis*) form before the tendril has come in contact with the wall. A similar development is true of the aërial roots of ivy, etc.

Nectaries have developed according to the same theory—namely, insects having been attracted to the juicy parts, withdraw the liquid and cause a flow of secretion, and finally a gland results. This is not unlike the statement that the excellence of milch-cows is largely due to the stimulation produced upon the milk-glands by the hands of the milker. Floral nectaries are correlated with pollination, they being invariably so placed as to subserve cross-pollination by insects.

It is shown by a long list of examples that sensitiveness and irritability are common phenomena in plants, whether in protoplasm, movements of organs, or formation of tissues, and the theory in hand is but an application of a general principle to the development of a particular part of the flower. The existing floral structures have been evolved under the mechanical and physiological impulses due to insect agencies. The colors of flowers, with all the display of streaks, etc., as path-finders to the nectaries, accord with the theory. "Instead, therefore, of a flower having first painted a petal with a golden streak to invite the insect and to show it the right way of entering, the first insect visitors themselves induced the flower to do it, and so benefited the future comers." The author's discussion of heterostylism—i. e., the different lengths of styles and stamens in the same species—is of great interest, especially that portion which deals with the origin of this condition in flowers. He assumes a homomorphic form as the primitive type, and dimorphism has been effected by varying degrees of stimulus, through insects, being applied to stamens and pistils, so that one set of organs may have been raised while the other was lowered. The lengths finally became so fixed that the best adaptation for cross-fertilization is thereby secured. This view not only ascribes to insects the original cause of variation, but that of the final stability in the dimorphic or trimorphic type. In summing up the treatment of metamorphosis of flowers, both progressive and retrogressive, Prof. Henslow concludes that the vascular cord is the fundamental floral unit, and, as these cords are identical before differentiation, it is not beyond expectation that petals may arise in place of stamens or stamens take the ordinary position of pistils. The primary cause may be less apparent, but doubtless it is in accordance with the governing action of environment modified by heredity. The conclusion drawn upon the somewhat obscure subject of fertilization is, "not that self-fertilization is *per se* in any way injurious, but that flowers which are normally sterile by having become so highly differentiated through insect stimulation do not now spontaneously set seed, and self-fertilization is not so efficient as crossing." Prof. Henslow has endeavored to make "a good theory of variation," and gives a direct cause for structural forms. He claims that the use of the expression "natural selection" leaves the subject where it was before. "Instead, therefore, of using this term as the cause of anything and everything, I prefer to attribute effects to hypertrophy, atrophy, resistance to strains, responsive action to irritations, and so on." It is possible that "natural selection" may underlie all these, and be so understood by many. As to the origin of a flower, the author thinks that it is only necessary to assume a leaf-bud, some of the members of which have differentiated into floral organs of the simplest type, as seen in the gymnosperm. Insects frequently search for pollen only, and by piercing the juicy tissues of such primitive flowers would introduce a series of changes which in time result in conspicuous blossoms. Whether or not the theory is accepted in all its many bearings, it is certain that every botanist must feel under obligations to Prof. Henslow for the excellent volume he has prepared, for the great array of facts therein, and the clear, concise manner in which the theory has been presented from first to last.

INDUSTRIAL LIBERTY. By JOHN M. BONHAM. New York: G. P. Putnam's Sons. Pp. 414. Price, $1.75.

THE author of this essay has evidently thought long and well on his topic. He has sought to treat the subject of industrial liberty in a manner somewhat different from that in which it has usually been discussed; and, aiming to keep in view principles rather

than statistics, he has undertaken to make an analysis of the salient political and industrial evils of our time, and to measure by fundamental rules the departure, in some of our governmental and industrial methods, from those principles. Such a purpose, it may be observed, implies considerably more than a superficial view of the labor and other questions "of the day," and regard to measures more abiding than the usual makeshift expedients. Whoever reads the book may not agree with the author, but he will have taken in that which will promote thought. Industrial liberty is defined to consist "in the freedom of each individual citizen, guarded by such delegated authority contributed by each as is necessary to preserve this individual freedom equally to each; and this liberty includes the freedom of each individual citizen to contract, and the sanctity of contract." The subject of the treatise is the effect which the world's development in industry and in political ideas, the growth of great industrial concerns, and modern practice in legislation, have had and are having upon the working of this principle. Steam and mechanical inventions have worked a complete change in the conditions of industry. Has it been for good? Mr. Griffin in England, and Mr. Atkinson in America, answer from statistics that, so far as physical wants are concerned, it apparently has. But it is not the workman's absolute present condition, "so much as a comparison of that condition or a contrast of it with the conditions around him, that comes into question. In other words, it is the increased disparity which constitutes his ground for discontent. Indeed, it is easy to understand that the bettered physical condition of the laboring man may of itself be a reason for his discontent, when we consider that this better condition has brought with it a better discerning faculty, a better power for comparing and contrasting conditions, and an improved capacity for reasoning upon differences." Another potent factor of recent growth in determining the conditions of the present time is the industrial corporation, which, having become monarch of the chief fields of enterprise, has been made a trust for the benefit of those who manage it, at the expense of the public for whom it is in theory supposed to have been primarily instituted, and even of a considerable portion of its own constituency. The corporation has had saddled upon it, to prey upon the public and bind it, the new form of trust, which is denominated a "parasite," and comes accompanied by other parasites upon industrial liberty. The histories of the growth of the great railway monopolies and the trusts which they carry, and of the Standard Oil and the gas trusts, are related. The remedy for these evils may be sought in treating corporate managers as trustees for the public; but the obstacles in the way of reform are formidable. They are reviewed at length. The influence of protection—which is declared to be a theory and not a principle—is next considered, and found to be not good, but in violation of natural law and encouraging to "trusts." A paternal government is defined and condemned as one which "in any way erects or creates obstacles tending to interfere with the industrial incentives and equal political rights of the citizen, or which fails to prevent the creation of such obstacles, or to remove existing ones." Under this *dictum*, protection, permission of discriminations, the common-school system, legal-tender government obligations, priority of liens, and business enterprises, direct or indirect, by the government, are condemned; but supervision and control of the government's artificial creations—corporations—in matters affecting the rights of citizens; administrative acts for the whole people; regulation of the traffic in intoxicants and poisons, prevention of food adulterations, and other acts of police, are not paternal, but within the proper sphere of government. The author's views respecting the common-school system, being different from those generally prevailing, are dwelt upon at length. Paternalism is less prevalent in America, and we have a great advantage in the freedom with which land may be alienated; but in both England and America a great deal remains yet to be accomplished; and much is hoped for the man who will be the product of the next civilization.

THE CHEMICAL ANALYSIS OF IRON. By ANDREW A. BLAIR. Philadelphia: J. B. Lippincott Company. Pp. 282. Price, $4.

THIS work is intended to embrace all the methods of value to the iron analyst. It

opens with a fully illustrated description of the necessary apparatus, many of the special forms of which are the author's own invention; this is followed by directions for preparing the reagents. Methods are then given for determining all the elements likely to be found in pig-iron, bar-iron, or steel, also for slag and oxides, several processes usually being given for each substance. Under carbon, the determination of total carbon, graphitic carbon, and combined carbon, are described. Methods for the analysis of iron-ores follow, also for the analysis of limestone, clay, slags, fire-sands, coal, coke, and gases. Tables of chemical factors, percentages of P and P_2O_5 for each milligramme of $Mg_2P_2O_7$, of tension of aqueous vapor, and for reducing volumes of gases to the normal state, are appended. The volume is copiously illustrated, and its print is large and clear.

THE ARYAN RACE: ITS ORIGIN AND ITS ACHIEVEMENTS. By CHARLES MORRIS. Chicago: S. C. Griggs & Co. Pp. 347. Price, $1.50.

AN exhaustive treatment of the above subject would fill many thick volumes, but the purpose of the author of the present work has been rather to give a brief outline of the history of that race from which the most cultured and powerful nations of the modern world have sprung. Mr. Morris discusses the several theories as to where was the home of the Aryans, and in what order and by what routes the different divisions of the race streamed out over Europe and Asia. He then gives a sketch of their customs and religion in their ancient home, and traces the course of their political development and of the development of the Aryan languages. The Aryan literature, and some other Aryan characteristics, also receive attention. Mr. Morris assures us that "all the statements concerning questions of fact have been drawn from trustworthy authors." The style is popular, and the author hopes "that the work may prove of interest and value to those who simply desire a general knowledge of the subject, and may in some measure serve as a guide to those more ardent students who prefer to continue the study by the consultation of higher authorities."

THE PRESENT CONDITION OF ECONOMIC SCIENCE, AND THE DEMAND FOR A RADICAL CHANGE IN ITS METHODS AND AIMS. By EDWARD CLARK LUNT. New York: G. P. Putnam's Sons. Pp. 114. Price, 75 cents.

THE author assumes, that while the doctrines of political economy have at no period shared largely in the public confidence, lack of confidence has in recent times become increasingly prevalent. The disrepute is explained by reference to the many conceptions of the science that are afloat; the disputes of economists; the "dismal" aspect which discussions have been made to assume the "bias that has been given by personal interests to the discussions; and the mistakes that have been made." The English method is criticised and objected to as being too deductive, too absolute, overfond of competition, and too reliant upon the *laissez-faire*, or "let-alone." The "new school" is sketched on its positive side as making the use of history a leading feature; and the value of this feature, and the extent and qualifications under which it may be safely applied, are discussed. This school has a good title to novelty in merging economics in the general science of sociology; and makes an attempt to unite ethics with political economy, which is pronounced impracticable and perversive. Finally, the new school lacks the great essential of a reason for existing, and, "as for scientific method in economics, the time seems now to have arrived when discussion is uncalled for, and when the question may safely be left to settle itself."

A TEXT-BOOK OF BIOLOGY. By J. R. AINSWORTH DAVIS. Philadelphia: P. Blakiston, Son & Co. Pp. 462. Price, $4.

THE author of this work is Lecturer on Biology in the University College of Wales. The book is designed for the use both of students who are studying alone, and those who are working under guidance. It is "divided into two parts, a botanical and a zoölogical, each of which deals with a number of types morphologically and physiologically, then briefly draws out the points of comparison between them, and ends with an outline of classification." A bibliography, and a set of examination questions, most of which are reprinted from the London Uni-

versity calendars, are appended. There are also separate index-glossaries for the two parts of the book, though a single index would be more convenient. The text is illustrated by one hundred and fifty-eight figures. In the vegetable part, representatives of the fungi, algæ, mosses, and ferns are described. The Scotch fir is taken to represent the gymnosperms; but as the angiosperms show such a great variety in form and structure, a general outline of the group is given, the various points being illustrated by, for the most part, common examples, instead of describing two or three species as representatives of the group. The part devoted to animals occupies about twice the space of that devoted to plants. The vertebrates are represented by the frog, pigeon, and rabbit. While the book contains no directions for manipulation of specimens, the parts of each organism are fully described, and the numerous cuts are minutely lettered.

SYNOPTICAL FLORA OF NORTH AMERICA: THE GAMOPETALÆ. Vol. I, Part II, and Vol. II, Part I. By ASA GRAY, LL. D. Published by the Smithsonian Institution. New York: Ivison, Blakeman, Taylor & Co. Pp. 480 and 494.

THE two portions of the late Prof. Gray's monumental work which have been so far published are reissued in the present volume. These parts together comprise all the gamopetalous dicotyledons. Vol. II, Part I, first published in 1878, has been extended by a supplement of seventy pages, and a complete index of genera, species, etc. A few pages of the text have been recast, and various minor corrections have been made. To the other part, published in 1884, a supplement of eleven pages has been added, and its full index has been made anew. The completed division constitutes the middle half of the entire flora, the author's design being to prefix an account of the *Polypetalæ*, forming Part I of Vol. I, and to add a second part of Vol. II, dealing with the *Apetalæ*, and Vol. III on the *Monocotyledons*. Vol. I would thus cover the ground of the two volumes of a "Flora of North America," published by Profs. Torrey and Gray in 1840 and 1843. Prof. Gray was occupied with his great work close up to the time of his death. All botanists will share the regret that he could not have been spared to bring the "Flora" to its completion, and will hope to see the remaining labor finally performed by hands familiar with the methods of the beloved master.

THE TARIFF HISTORY OF THE UNITED STATES: A SERIES OF ESSAYS. By F. W. TAUSSIG. New York: G. P. Putnam's Sons. Pp. 269. Price, $1.25.

THE papers comprised in this volume were written at different times and have been published through different channels; but they have been revised, pruned, and added to so as to form a harmonious whole, and as they now appear give a fairly connected history of tariff legislation and its workings from 1789 to 1887. The author admits that there may be conditions in the history of a country where a temporary qualified protective policy may be of advantage. Thus, "the transition from a purely agricultural state to a more diversified system of industry may be retarded, in the complete absence of other occupations than agriculture, beyond the time when it might advantageously take place. Secondly, when great improvements take place in some of the arts of production, it is possible that the new processes may be retained in the country in which they originate, and may fail to be applied in another country, through ignorance, the inertia of habit, and perhaps in consequence of restrictive legislation at the seat of the new methods. Here, again, the obstacles to the introduction of the new industry may be of that artificial kind which can be overcome most easily by artificial means." Yet, notwithstanding "both these sets of conditions seem to have been fulfilled in the United States at the beginning of the present century," the lesson drawn from the history of each of several leading branches of manufacture is, that protection has been of very little effect upon its growth. While cotton was probably assisted by the tariff of 1816, its manufacture was securely established before 1824, and "the further application of protection in that and the following years was needless, and, so far as it had any effect, harmful. . . . It appears that direct protective legislation had even less influence in promoting the introduction and early growth of the woolen than of the cotton manufacture." And it is concluded that

"the duties on iron during the generation after 1815 formed a heavy tax on consumers; that they impeded, so far as they went, the industrial development of the country; and that no compensatory benefits were obtained to offset these disadvantages." The history shows also that three different arguments have been urged at different times in favor of protection. First was the "young industries" argument, which began to lose strength shortly after 1832; next was the "home market" argument, to which the situation during the War of 1812 gave some vigor; and last was the argument based on the difference in wages in Europe and the United States, which, curiously, was first a free-trade weapon before the protectionists took it up. As a whole, "one does not find in the popular discussions of fifty years ago, more than in those of the present, precision of thought or expression." Through all tariff changes and discussions our manufactures kept on growing, as they would have done under any circumstances, Prof. Taussig seems to believe, by the sheer force of the nature of things. The history of the existing tariff is given with considerable fullness.

PTOMAINES AND LEUCOMAINES. By VICTOR C. VAUGHAN, Ph. D., M. D., and FREDERICK G. NOVY., M. S. Philadelphia: Lea Brothers & Co. Pp. 316. Price, $1.75.

TOXICOLOGY, the field in which the three domains of the chemist, the doctor, and the lawyer come together, has had its boundaries enlarged within the past ten years by the addition of the putrefactive and the physiological alkaloids. In this short period the activity of various investigators has brought to light a large number of facts concerning these substances. To collect, arrange, and systematize these discoveries, the reports of which were scattered through many journals, transactions, and other publications, has been the first object of the authors of this volume.

The work opens with a historical sketch of the subject, which is followed by a chapter of cases of poisoning by foods containing poisonous ptomaines. Poisoning by cheese and milk is treated with especial fullness, Prof. Vaughan being especially qualified to speak on this subject, since he is the discoverer of tyrotoxicon. The relation of ptomaines to disease is next taken up, and five theories which have been proposed in answer to the question, How do micro-organisms produce disease? are examined. The theory that the symptoms of infectious disease are caused by chemical poisons, ptomaines, which the bacilli produce by splitting up complex compounds in the body, is deemed by the authors practically demonstrated, and they cite the evidence for this theory as regards anthrax, cholera, tetanus, and other diseases. In the next chapter certain ptomaines which resemble in their reactions the vegetable alkaloids are described, and the danger of mistaking the former for the latter is pointed out. Several methods of extracting ptomaines are given, and the chemical descriptions of a large number of these substances follow. Similar descriptions of the leucomaines are given, and a twenty-page bibliography of the two classes of substances closes the volume.

Vol. IV, No. IV, of *Studies from the Biological Laboratory* of Johns Hopkins University (N. Murray, Baltimore, $1), opens with a short paper by Prof. W. K. Brooks, on "The Life-History of Epenthesis McCradyi," a species of hydro-medusa, illustrated with three plates. This is followed by "Observations on the Development of Cephalopods: Homology of the Germ-Layers," by S. Watase, with two plates. There are also two papers by F. Mall, M. D., one on "Development of the Ear of the Chick," with two plates, and the other on "The Branchial Clefts of the Dog, with Special Reference to the Origin of the Thymus Gland," with three plates. Mr. T. H. Morgan reports some "Experiments with Chitin Solvents."

The California Florist (Santa Barbara, Cal., $1 a year) is an illustrated monthly devoted to Pacific coast floriculture. It is popular and practical in character, and is edited with intelligence and good taste. The first number was that for May, 1888.

Mr. *Hubert Howe Bancroft* has prepared, and the History Company, San Francisco, publishes, uniform with the series of the "History of the Pacific States of North America," *California inter Pocula*, or "Cali-

fornia in her Cups"—a picture of what have been called the "flush times" of that State; or of its age of gold-hunting. The period and the scenes covered by the story were probably unique in the history of the world. Ordinary historical narrative can, as the author intimates, hardly do justice to them, because they were "so full of oddities, and crudities, and strange developments, consequent upon unprecedented conditions," that "to condense them into the more solid forms of history without to some extent stifling the life that is in them, and marring their originality and beauty, is not possible. There are topics and episodes and incidents which can not be vividly portrayed without a tolerably free use of words—I do not say a free use of the imagination." The record is therefore set off in a volume by itself, and given as an accompaniment to the history proper rather than as a part of it. The account begins with a description of the "Valley of California," its peculiar features and scenery. Then the review of "Three Centuries of Wild Talk about Gold in California," to which little value is attached as indicating any conception of the wealth which the country held, is followed by the story of the discovery of gold by Marshall, given in highly dramatic style and with the variant versions. The emigration from the East naturally follows, by its several routes, overland and by sea—giving opportunity to present vivid pictures of conditions that are past never to return. The circumstances which the emigrants found, or made, when they reached the El Dorado, are next in logical order, and are portrayed to a large extent in lively anecdote. These conditions include society in San Francisco and at the mines; the anomalous condition in which the emigrants found themselves in the entire absence of the influences of home and woman; mining life and customs; the administration of justice; the prevalence of drinking, gambling, and dueling; and Chinese and Indian episodes. A full account of the Modoc campaign is given under the last-mentioned head.

Additional volumes in G. P. Putnam's Sons' series of "English History by Contemporary Writers" are *Simon de Montfort and his Cause*, selected and arranged by the Rev. *W. H. Hutton*, and *Strongbow's Conquest of Ireland*, by *Francis Pierrepont Barnard*. The former volume gives the story of one of the most important and exciting series of events in the history of England—including the close of the struggle between crown and barons—from the writings of Robert of Gloucester, Matthew Paris, William Rishanger, Thomas of Wykes, and other chroniclers. The second volume deals with the first contact between the newly organized feudalism of Anglo-Roman England and the far older and more primitive civilization of the last independent Keltic states. It is made up of translations from a great many writers, all of the "olden time." Besides the interest and importance attached to the stories themselves, there is a peculiarly rare flavor about the books of this series, derived from the antiquity of the authors and the *naïve* style in which they wrote, so different in many of its features from modern composition.

The Historical American, "an illustrated monthly magazine of history, literature, science and art" (M. H. Meagher, Cleveland, $3 a year), issued its first number in July. Some of the chief articles of that issue are "Abraham Lincoln" (with portrait), by Henry C. Long; "Thomas Paine" (with portrait), by Colonel William Henry Burr; "True and False Civil-Service Reform," by Lester F. Ward; and "The Projects of Aaron Burr," by Charles H. Creighton. Under the heading "Notes and Comments" are printed Colonel R. G. Ingersoll's Decoration-day address, and extracts from an address by T. B. Wakeman, in defense of protection, before the Nineteenth Century Club of New York.

Stories of other Lands, compiled and arranged by the late *James Johonnot* (D. Appleton & Co.), is a reading-book of the historical series, designed for older pupils than those for whom the other volumes of the series were intended. It presents, in extracts from the works of standard authors, in prose and poetry, striking incidents in the histories of Spain, France, central Europe, and Great Britain, in the lives of artists, in the record of science and industry, and miscellaneous stories. The whole are designed and adapted to excite such an interest as will lead the pupil to more extensive read-

ing, particularly in the fields which are opened out by the selections.

C. N. Caspar, of Milwaukee, has announced a *Complete Volapük Dictionary; in Volapük-English and English-Volapük*, by *Klas August Linderfelt*. It is based on the last editions of the dictionaries of Schleyer and Kerckhoffs. Schleyer's dictionary is said to contain more than twenty thousand words, from which it will be seen that Volapük already has a considerable vocabulary. A new feature is added in the present work, in indicating the source and language from which each Volapük word is derived. From this it appears that more than sixty per cent of the radical words have their origin in the English language. Prof. Linderfelt's manual of Volapük has been very successful, three editions of four thousand copies each having already been published.

The ninth and tenth volumes of the *Bulletin of the Philosophical Society of Washington* (Smithsonian Institution, publisher), bound in one, contain the minutes of the society and of the Mathematical Section for 1886 and 1887, together with the proceedings of the Baird memorial meeting. A number of valuable papers are included in the *Transactions*. Among them are two presidential addresses: the first, by John S. Billings, at the December meeting of 1886, on "Scientific Men and their Duties"; and the second, by William Harkness, in 1887, on "The Progress of Science as exemplified in the Art of Weighing and Measuring." Another valuable paper is the discussion of the Charleston earthquake. The addresses at the Baird memorial meeting, by Messrs. Garrick Mallery, William B. Taylor, William H. Dall, and J. W. Powell, present incidents and estimates and illustrations of Prof. Baird's character from several points of view.

The Woman's Temperance Publication Association, Chicago, publish, under the title of *Our Standard-Bearer*, the life sketches and speeches of General Clinton B. Fisk, Prohibition candidate for President, by the Rev. *John O. Foster*, with an introduction by *Frances E. Willard*. Although primarily designed for a campaign document, the work is something more, and contains a pleasing miscellany of "army stories" and a record of active participation in works of benevolence.

The seventh volume of the *Archivos do Museu Nacional* (Archives of the National Museum), of Rio Janeiro, is of particular interest to us, because it is all the work of American students and authors. It includes the results of the studies of the Cretaceous invertebrate fossils made in the course of the prosecution of the Brazilian geological survey, under the direction of Prof. C. F. Hartt, which fossils were carefully preserved by Mr. Orville A. Derby, as director of the Geological Section of the National Museum, and have been examined by Dr. Charles A. White, of Washington, whose report upon them and specific descriptions constitute the text of the work. Twenty-eight plates of illustrations accompany the letterpress.

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Yale University, Observatory of. Report for 1886–'87. Pp. 15.

POPULAR MISCELLANY.

The Value of Scientific Teaching.—The chief value of scientific study, in Sir James Paget's view, is not merely in teaching facts, but in teaching the methods by which facts and principles may be obtained. Four great truths are taught by scientific education: those of the power of observation; of accuracy; of the difficulty of getting a knowledge of real truth; and of methods by which we can pass from that which is proved to the thinking of that which is possible. How difficult it is really to observe, is proved by every scientific discovery that is made; for each such discovery rests upon the clear observation of facts that have been within the range of sight of many, but previously overlooked. Science is essentially founded on accurate observation and accurate record and arrangement; and these are made more feasible by cultivating the habit of recording the facts while they are in sight—as an artist secures a correct portrait by looking at the object time and again, and painting accurately each time what he has seen. Science ought to be as accurate as art. Scientific education has the very rare value of demonstrating the utility of the most careful investigation, and of repeated observation, test, and examination; and it may fairly claim—which is its common boast—that it engenders a love of truth. The name of Sir John Lubbock should be a sufficient answer to the belief that scientific pursuits are not compatible with ordinary business occupations. The habits induced by such occupations may even aid science, by discerning some practical utility at the end of certain lines of work, and thereby sharpening the interest with which they will be pursued.

Officers of the American Association.—The following are the officers of the American Association for the ensuing year: *President*—T. E. Mendenhall, of Terre Haute, Ind. *Vice-Presidents*—A. Mathematics and Astronomy, R. S. Woodward, of Washington, D. C.; B. Physics, H. S. Carhart, of Ann Arbor, Mich.; C. Chemistry, William L. Dudley, of Nashville, Tenn.; D. Mechanical Science and Engineering, Arthur Beardsley, of Swarthmore, Pa.; E. Geology and Geography, Charles A. White, of Washington; F. Biology, George L. Goodale, of Cambridge, Mass.; H. Anthropology, Garrick Mallery, of Washington; I. Economic Science and Statistics, Charles S. Hill, of Washington. *Permanent Secretary*—F. W. Putnam, of Cambridge, Mass. (office, Salem, Mass.)—Holds over. *General Secretary*—C. Leo Mees, of Terre Haute, Ind. *Secretary of the Council*—Frank Baker, of Washington. *Secretaries of the Sections*—A. Mathematics

and Astronomy, G. C. Comstock, of Madison, Wis.; B. Physics, E. L. Nichols, of Ithaca, N. Y.; C. Chemistry, Edward Hart, of Easton, Pa.; D. Mechanical Science and Engineering, James E. Denton, of Hoboken, N. J.; E. Geology and Geography, John C. Branner, of Little Rock, Ark.; F. Biology, Amos W. Butler, of Brookville, Ind.; H. Anthropology, W. M. Beauchamp, of Baldwinville, N. J.; I. Economic Science and Statistics, J. R. Dodge, of Washington, D. C. *Treasurer*—William Lilly, of Mauch Chunk, Pa. *Auditors*—Henry Wheatland, of Salem, Mass.; Thomas Meehan, of Germantown, Pa. The Secretary announced the selection of the following committees, and their election followed: *On Chemistry Teaching*—W. H. Seaman, William L. Dudley, W. H. Wiley, W. O. Atwater, and W. A. Noyes. *On Water Analysis*—G. C. Caldwell, J. W. Langley, J. A. Myers, W. P. Mason, R. B. Warder, and W. H. Seaman. *On Organization of a National Chemical Society*—A. B. Prescott, Alfred Springer, and Edward Hart. Dr. A. B. Prescott was appointed substitute for Dr. Scudder on the Committee on Indexing Chemical Literature. The next meeting was appointed to be held in Toronto, on the last Wednesday of August, 1889.

Metamorphosis of Caddis-Flies.—Mr. J. H. Comstock has had the opportunity of observing a caddis-fly—in his aquarium—leave the water and take its first flight. "It swam to the surface of the water repeatedly," he says, in the "American Naturalist," "using its long mesothoracic legs. When swimming, these legs were extended at right angles to the body, like a pair of oars. The insect was unable to crawl up the vertical side of the aquarium, and, after clinging to it for a short time, it would lose its hold and sink back to the bottom. After watching it for a time, I lifted it from the water by means of a stick. At this time its wings were in the form of pads, which were but little, if any, larger than the wing-pads of the pupa, as shown by the cast pupa-skin found floating on the water. The instant the creature was free from the water, its wings expanded to their full size, and immediately it flew away several feet. In my efforts to catch the insect, I found that it had perfect use of its wings, although they were so recently expanded. The time required for the insect to expand its wings and take its first flight was scarcely more than one second; it was certainly less than two. As these insects normally emerge from rapidly flowing streams which dart over rocks, it is evident that if much time were required for the wings to become fit for use—as is the case with most other insects—the wave succeeding that which swept them from the water would sweep them back again and destroy them."

Some Laws of Heredity.—In a course of anthropological lectures at the South Kensington Institution, Mr. Francis Galton laid down, as a measurement of the influence of heredity, that each child inherits, on an average, one fourth of the personal peculiarities of each parent; one sixteenth of those of each grandparent, etc.; and that, if the previous ancestry are left out of account, the influence of each parent is raised to one third. From these laws, schemes of children, grandchildren, nephews, etc., can be constructed, though the particular place of any individual in any such scheme can not be predicted. Family likenesses and family differences; the stability of type in a population; the silent transmision of ancestral characteristics, and blended and mutually exclusive heritage, were illustrated by the metaphor of vegetation on two islands spreading over adjacent islets. The lecturer spoke approvingly of the measures adopted to promote higher physical culture by the establishment of special departments at Amherst and Harvard Colleges, and of the attention paid to the subject elsewhere. The purpose of the lectures was to discuss the influences that tend to produce the aggregate of the most favorable conditions for healthy and happy existences.

Hispaniolan Smokers.—The aborigines of Hispaniola, or Hayti, had a powder, cohoba, the smoke of which they inhaled through their noses. It was probably a preparation of tobacco. Oviedo (1526) describes the smoking of it through the nose, thus: "The instrument with which they inhaled the smoke was a forked hollow tube about a palm in length, and of the thickness of a little finger, well polished, well made, all of one piece. They inhaled the smoke as long

as they could, in fact until they fell down drunk. Those who could not afford such tubes made use of reeds." These tubes or reeds, Oviedo says, were called tobacco. Benzoni gives the following account of cigar-smoking: "When these leaves are in season, they pick them, tie them up in bundles, and suspend them near their fireplace till they are very dry; and when they wish to use them they take a leaf of their grain (maize) and, putting one of the others into it, they roll them round tight together; then they set fire to one end, and putting the other end into the mouth, they draw their breath up through it; wherefore the smoke goes into the mouth, the throat, the head, and they retain it as long as they can, for they find a pleasure in it, and so much do they fill themselves with this cruel smoke that they lose their reason. And some there are who take so much of it, that they fall down as if they were dead, and remain the greater part of the day or night stupefied."

Stellar Atmospheres.—Orray T. Sherman, in studying the stellar spectra comprising bright lines, has observed that, while persistent in place, the bright line is not persistent in intensity. This peculiarity affords a distinction between bright-line light, bright-background space, and any accidental disturbance the spectrum light may suffer. Collating his own observations, particularly those which he applied to β Lyræ, with Lockyer's results in the study of the solar atmosphere, we may, he says, "picture to ourselves the condition of the stellar atmosphere and the action therein somewhat as follows: An outer layer of hydrogen positively electrified, an inner layer of oxygen negatively electrified, and between them a layer of carbon mingling on its edge with hydrogen. The electric spark passing through the mixture forms the hydrocarbon compound, whose molecular weight carries it into the oxygen region, when combustion ensues with the formation of carbonic acid and aqueous vapor, both of which, descending under the influence of their molecular weight, are again dissociated by internal heat, and return to their original positions. Under the insight which this result gives we have found the spectra of the nebulæ referable to low excitation hydrogen, the spectra of the bright-line stars referable to high excitation oxygen, and hydrogen of higher or lower excitation according as the central star is of high or low magnitude, and, as far as the accuracy of the observations permits, τ Coronæ, Nova Andromeda, Nova Cygni, and the star near χ Orionis, itself a variable, likewise referable to the same spectra similarly conditioned. There is also reason for thinking that a similar atmosphere in similar physical conditions lies between us and the sun, and it seems as if we might consider that from the faintest nebula to the most highly finished star we have but progressive stages of the phenomenon here presented."

Across Greenland.—Mr. M. Nansen is engaged in an attempt to cross Greenland from east to west, with the aid of the Norwegian *ski*, or snow-skates. The experience of past expeditions has shown that the most successful and farthest advances over the glacial tracts have been made by the scouts provided with these useful furnishings; and he hopes that with their aid a party accompanied by a sledge-load of provisions may cross the country in about a month. He confidently expects to find a snowless tract in the interior; and hopes, by the observations he will be able to take (only rough ones, of course), to add something to our climatological and meteorological knowledge. He will give special attention to the question of the *slam*, or dust deposit in the snow—which Nordenskiöld regards as cosmic, but he as telluric and derived from the snowless region—to the curious snow-plants, and to the fauna and flora, of which casual appearances near the sea-coast indicate that the country is probably not destitute. The party, consisting of Dr. Nansen and six companions, landed July 18th in lat. 65° 30′, or nearly two degrees south of the Arctic Circle, implying a journey of some three hundred miles across to the west coast. The two Laplanders, who accompanied Nordenskiöld in his second unsuccessful attempt to cross Greenland (in a higher latitude and from the west side), managed to advance eastward some hundred and forty miles, and attained a height of over five thousand five hundred feet, whence they got a view of what appeared to be an endless snow-field.

Hygienic Living.—Some independent opinions on health and disease are expressed in Dr. Allinson's book, "Hygienic Medicine." Our civilization is held to be the cause of many of our diseases; thus, the close confinement of our homes is chargeable for diseases of the breathing apparatus; the artificial warmth produced by fires, clothes, and hot foods and fluids is injurious. Many suffer from want of exercise, others from not keeping their skins clean. Reasoning from their structure, men should live on fruit, grain, and vegetable products, especially fruit; food and fluids should be taken lukewarm and not hot. All diseases being regarded as but one, with different names according to the locality where they manifest themselves, the author prescribes as the one remedy for all, hygienic living—consisting of proper food at proper intervals, pure air always, regular exercise, and clean skins. Drugs are good only to kill parasites on the skin or expel them from the intestines, and to produce anæsthesia during surgical operations and insensibility to unbearable pains; otherwise they do harm rather than good.

Profits of Forest Cultivation.—The history of forestry in India shows, according to the presentment of Mr. George Cadell, in "Macmillan's Magazine," how a revenue which, in the year 1886–'87, returned a surplus of 41,017,000 rupees, was built up, under systematic management, "from not only an entire absence of income, but from a rapidly diminishing capital." The means by which this gain was drawn in were, "restraining the destruction of the forests by the wood-merchants, who felled for the sake only of personal aggrandizement, . . . by guiding, without checking, the cutting of trees by the peasantry for their agricultural and building necessities," and by steering "an arduous course" between the necessity for restraining reckless waste, and the obligation for meeting legitimate demand. The returns of three years' forest administration in the canton of Vaud, Switzerland—1884, 1885, and 1886—show that the 24,500 acres of forest-land gave an average revenue of more than five shillings per acre. The French forest budget for 1886–'87 shows a surplus of 13,400,000 francs, or 5·25 francs per acre. The Prussian forests return a surplus of 23,900,000 marks, which is equivalent to a net income of 3·6 marks per acre. Lands in Great Britain are told of, the agricultural value of which is no more than twelve or fourteen shillings per acre, that bear larches which, when sold, realize from one shilling to one shilling and threepence for each cubic foot. A certain crop of Scotch fir seventy-five years old, standing on ground the annual value of which does not exceed ten shillings, is valued for transfer at £132 per acre. Generally, a crop of larch standing within reasonable distance of a railroad-station ought to be worth £50 or $250 an acre when fifty years of age. It should be remembered, too, that while ordinary agricultural operations exhaust the soil, trees enrich it.

Walloon Superstitions.—The Walloons of Belgium believe in all kinds of omens, including most of those which are common in other countries. Among their superstitions is one that to meet a priest, when about to undertake anything unusual, is a certain sign of failure, and puts a stop to further proceedings. Few will throw reeds into the fire, because they are of service to oxen; and an ox having been present at the Saviour's birth, it ought to be regarded as sacred. The bed of a dying person must be placed in such a position that the rafters can not run in a contrary direction to it; for, unless they are parallel, the agonies of death would inevitably be protracted. When linen is washed, the water is never said "to boil," but "to play"; otherwise, the clothes would be destroyed. Precious stones are supposed to possess virtues more valuable than their intrinsic worth. An aërolite is said to be unsurpassed as a means for discovering a thief. The metal must be ground to powder, then mixed with flour and made into bread, of which no genuine thief can swallow the smallest portion. On Easter-Sunday it was the custom to breakfast off of two eggs that had been laid on Good-Friday, in order to render the eater proof against fever. To abstain from meat after Lent was a cure for toothache. In taking a dead body to the church-yard, if they come to four cross-roads, the bearers put down the coffin, and all kneel to repeat a short prayer. The idea is

that those who have left the world are sure to return to it, and that, as there are four ways, the traveler might wander aimlessly about, not knowing in which direction his home lay; therefore his friends pray for him at one of the roads, so that he may choose the right path, and not be misled by evil spirits. The mock court of Coucou was held at Palleur every year in August, at the nearest inn, and then, by adjournment, on the bridge. All the henpecked husbands and those who possessed any peculiarity were summoned before it, when the most ridiculous pleadings were had, nonsensical questions were asked, and appeals on mooted points were made to strangers present. The accused were always found guilty, sentenced to pay a fine, which must be spent at the inn, and then put into a cart, which was backed to a suitable mud-hole or pool, where they were shot out. The proceedings ended with the trial and ducking of the last man married in the village.

Types of Cliffs.—Dr. Archibald Geikie, in his book on "The Scenery of Scotland viewed in Connection with its Physical Geography," describes how the configuration of the coast is affected by the action of the sea. This work is traced around the cliffs, and the overhanging rocks which skirt the coast of parts of Caithness and Orkney are consequences of the direction of the great joints which run at right angles to the dip of the beds, so that wherever the strata descend with their planes of bedding toward the sea, the cliffs overhang. The joints are often pierced, so that the sea penetrates inward. The encroachments of tidal waters are recorded all along the coast. There are three types of sea-cliff which owe their characters to the rock forming them. First, the crystalline schists and old gneiss, which form a range of precipices running northward on the west coast of Scotland to Cape Wrath; crumpled, folded, and irregularly jointed, it is strikingly rugged, full of deep recesses and tunnels, and buttresses which extend into the sea. A second type of cliff is formed by the Cambrian sandstones of the west coast. They rise a few miles to the east of Cape Wrath in vertical cliffs six hundred feet in height. The perpendicular joints separate masses from the main cliff, and everywhere present a red or brown tinge. A third form of cliff is produced by basalt, well seen on the west of Skye, where it rises in precipices reaching to one thousand feet above the sea. But owing to the varying durability of the basaltic rock, it weathers so as often to form steep descents, which characterize these ancient lava-streams.

Private Lunatic Asylums in Great Britain.—The fortieth report of the British Commissioners of Lunacy shows an increase both in the general number of insane patients and in the number of those confined in private asylums over the numbers reported in the previous year. The general increase is less and the increase in the number confined in private asylums is relatively still less than was the increase returned in the previous year over the year preceding it. The patronage of the private institutions seems to have been materially affected by the agitation that has been made respecting them. Medical men are averse to running the risk of being involved in actions, and decline to sign lunacy certificates. The friends of persons of unsound mind have learned to look upon the private asylums with distrust. The effect of some recent judicial decisions has been to permit many weak-minded but not dangerous persons, who would previously have been put under supervision, to go at large. But the commissioners profess to be satisfied that the impression that patients are unduly detained in these establishments is wholly unfounded, and say that the houses were generally conducted during the year to their satisfaction.

Bees as Weather Indicators.—Prof. Emmerig, of the Royal Seminary in Lauingen, Germany, recommends bees as the surest prognosticators of the weather for the day. These insects are usually among the most docile and good-humored of animals, and show no disposition to sting unless they are provoked. But, if a storm is impending, they become restless and irritable, and are dangerous to approach. Sometimes the barometers will give the most emphatic indications of a storm, while the bees will continue quiet. The storm may break somewhere else, but not where the bees have omitted to give warning of it, or, if it breaks there, it will be light.

Then the bees may predict a storm when the instruments indicate fair weather, and the bees will prove the truer prophets. Prof. Emmerig cites eight or nine incidents that have occurred under his own observation within three years, where the bees and the weather-glasses failed to agree as to what the day's weather should be, and the bees carried their point.

Capacity of Native Siberians.—N. Jadrinzen, who has recently published a book about Siberia, expresses in it favorable opinions respecting the capacity of the natives of that land to receive civilization and of their promise of talent. The Samoyeds, according to School-Inspector Abramov, are a quite capable people, and their children show themselves proficient in mathematics. The remarkable natural talents and wonderful vital energy of the Tunguses are set forth by Middendorff. The Yakuts have been distinguished from the olden time for their cleverness, and take readily to civilization. The Kirghis have furnished a considerable number of able men, and are distinguished for their strong wit and rich fancy. The Altaians are not less gifted in religious intuitions and mental faculties; and missionaries have given accounts of very intelligent persons among them. The Tilents and black Tartars show decided inclinations toward civilization and a settled life. The Sarts and Tartars are sharper traders than even the Russians. M. Jadrinzen hopes that the newly established University of Tomsk, as its activity and sphere of usefulness extend, will awaken these people out of the torpor and hopelessness into which they have fallen, to a new life of enterprise and advancing knowledge.

Running Amok.—One of the most curious and unaccountable manifestations of human aberrations is in the Malay custom of running "amok." It breaks out, apparently, under the impulse of a momentary passion, but appears to depend, in the Malay's mind, upon a kind of belief that the act is the proper thing to do. In other words it is a convention. An instance of the frenzy recently occurred at Singapore. A Malay hadji, a "personal conductor" of pilgrimages, received a message from Mecca announcing the death of his daughter. He instantly decided, to appearance, that it was not worth while under the circumstances for any one to live longer, and, drawing his creese, stabbed the owner of the house. A boy who was present ran away and bolted the door outside. The frenzied Malay escaped by the roof, went into another house, stabbed two women, returned to the street, killed a Chinaman, attacked some other persons, and was finally knocked down with a pole by a native policeman, after having wounded six persons and killed three in a very few minutes. He soon calmed down, and, when asked why he had acted thus, answered that he did not know. Mr. Frederick Boyle, in one of his books on savage life, describes his emotions when he saw amok coming upon a Malay servant who was in the woods with him, and the frantic passion stealing over his eyes, apparently without any occasion whatever.

The Matrix of the Diamond.—The rock—a porphyritic peridotite—in which the diamonds of South Africa are contained, has been microscopically examined by H. Carvill Lewis, and found to be one of the most basic rocks known, having a composition of equal parts of olivine and serpentine impregnated by calcite. In this structure and in some other points it presents some analogies with meteorites. It constitutes a new rock-type, for which the name Kimberlite is proposed. It probably occurs in several places in Europe, and is known in Elliott County, Ky., and at Syracuse, N. Y., in the United States, at both of which places it is eruptive and post-carboniferous, and similar in structure and composition to the Kimberly rock. In most other diamond localities, where the gems are found in diluvial gravels and conglomerates of secondary origin, the original matrix is hard to discover; but in Borneo, diamonds and platinum occur only in those rivers which drain a serpentine district, and in Timor Laut they also lie in serpentine districts. In New South Wales, serpentine occurs near each locality where there are diamonds, and the same is the case in the Urals. Diamonds have been found in the Carolinas, where peridotite occurs in great beds and serpentine is abundant. All the facts thus far collected indicate serpentine, in the form of a decomposed eruptive peridotite, as the original matrix of the diamond.

The Dullness of Anglo-Saxon Cities.—Mr. Frederic Harrison has made a complaint that English cities all over the world—with which American cities are classed—are dull and unattractive. The brightness of the life—at least among the better-endowed classes—which is recorded of the ancient cities of Greece and Rome, is not to be found in them; and the exhilarating vitality of Continental cities is likewise absent from them. They are healthy and rich beyond comparison with all other places, except, perhaps, ancient Rome, of corresponding importance, but, according to the summary of Mr. Harrison's lecture, they are dull abodes, usually wanting in beauty, seldom adorned with really admirable public buildings, filled with homes that give no pleasure to the eye, and over a great part of their area squalid, monotonous, and dingy. There are few festivals, and little real civic common life; the best classes withdraw their interest and declare the cities intolerable; the masses, except in their personal security, derive but little benefit from the organizations amid which they live. Life for the majority is deprived of the pleasantness which attaches to life in the country, and gives no compensations except those which are derived from the presence of great numbers. Mr. Harrison thinks that the size of the great cities is a drawback to their pleasantness, and this may be, to some extent, true; but a more satisfactory way of accounting for the condition may probably be found in the spirit of speculation which seeks to make money out of everything, preferring it to enjoyment, and plants noisome factories, with steam-engines and vapors, and racket, as near to all large centers of population as it can get them.

Effects of Petroleum Emanations on Health.—The influence of petroleum emanations upon health have been investigated by M. Wiecyk in the Carpathian region, where the workmen have to breathe an atmosphere that is tainted with carbureted hydrogen, carbonic acid, ethylene, various hydrocarbons, carbonic oxide, and sulphureted hydrogen. Cases of asphyxia are not rare. The affections ordinarily incident to long-continued work are tinglings in the ears, dazzling, beating of the arteries of the head, syncopes, and hallucinations, usually of pleasant character. The first feeling on breathing the vapors is one of lightness in the breast and greater freedom in respiratory movements; but this is soon succeeded by palpitations and general weakness. Diseases of the chest, particularly tuberculosis and epidemic and infectious disorders, are rare; a consequence, probably, of the antiseptic qualities of the vapors.

Andaman Island Myths.—The Andaman-Islanders, according to Mr. J. A. Farrer, in the "Gentleman's Magazine," believe the rat, crow, fish, eagle, heron, jungle-fowl, shark, porpoise, and various other animals, to be transformed ancestors, and have a definite legend to account for the transformation in each case. A certain fish, armed with a row of poisonous barbs on its back, is a man who committed murder in a fit of jealousy; and a tree-lizard retains the very name by which the victim was known as a man. The first human being of all fell into a creek and was drowned, when he was transformed into a whale and became the father of cetaceans. He capsized and drowned his wife and grandchildren while they were in a boat looking for him, and she was transformed into a crab, and his grandchildren into iguanas.

The White Mountain of Manchuria.—Mr. H. E. M. James, of the Indian Civil Service, and two companions, have made a journey through the Chang-pei-shan Mountains of Manchuria, and visited the sources of the river Sungari, thus penetrating to a district which had not previously been reached by Europeans. At Maoerh-shan, on the Yaloo, they found their progress up the river barred by impracticable precipices, while the few colonists of the upper valley had to depend upon the river when frozen in winter for intercommunication. They, therefore, changed their course to the valley of another stream. The Pei-shan, or White Mountain, from which the region they visited derives its name, proved to be an extinct volcano, with a blue pellucid lake filling the bottom of the crater, and surmounted by a serrated circle of peaks rising about 650 feet above the surface of the water. The sides of the mountain, which are steep, are composed entirely

of disintegrated pumice-stone, to which the peak owes its conspicuously white aspect when seen from afar. It can be reached only during the summer months, for snow prevents access to it at other times. The lake, whose name signifies the Dragon Prince's Pool, is six or seven miles in circumference, and is believed by the hunters to be under the special protection of the god of the sea. The inner sides of the crater looking down upon it are very precipitous. From its northern end a small stream issues, which becomes the eastern or smaller branch of the Sungari, while the main or western branch owes its origin to several streams rising on the southeast face of the mountain, two of which flow out in handsome cataracts. From the number and character of the rivers that rise in the vicinity, the Pei-shan Mountain is shown to be the very core and center of the river system of Manchuria.

NOTES.

Wood-creosote oil is recommended by Captain W. H. Bixby, in the Forestry Department's "Report on the Relation of Railroads to Forests and Forestry," as possessing valuable antiseptic properties. It is an efficient poison to animal and vegetable life; it thoroughly repels moisture, and its tar acids possess the power of coagulating albuminous and other fermentable matter. It forms an excellent insecticide, and is one of the best possible oils for preserving lumber and piling. Painted upon wooden or metallic surfaces, it preserves them from wet and dry rot, rust, and the attacks of insects. Forced into wood by hydraulic pressure, it will fill all the pores, extending its coagulating and antiseptic effects to the very center of the block. It is distilled on a considerable scale, in North Carolina, from the wood of the Southern *Pinus palustris*.

From a comparison of specimens of chipped implements from different sources—of flint nodules from Abbeville and St. Acheul, France, and Milford Hill, England; of argillite from Trenton, New Jersey; of quartz from Little Falls, Minnesota; and of black chert from the Little Miami, Ohio—Prof. F. W. Putnam has expressed the conclusion that man, in this early period of his existence, had learned to fashion the best available material, be it flint, argillite, quartz, chert, or other rocks, into implements and weapons suitable to his requirements; and that his requirements were about the same on both sides of the Atlantic, with conditions of climate and environment nearly the same on both continents. This brings up for future investigations the question whether he was the same on both continents, and whether he has left descendants or has passed out of existence.

A philosophical definition of luck is given by an English writer as a capability of being incapable. "The first Rothschild was probably right, from his point of view, when he said that he never would employ an unlucky man. On the other hand, the lucky man is usually the man who fits his fortunes; who, whether apparently able or stupid, can do just what his especial circumstances require him to do. Very stupid men are often ready men, armed with a readiness as of dogs when they twist from under a cart-wheel unhurt. The 'fool who makes a fortune' is usually a man with just the foresight, or just the judgment or the intuitive perception of the way things are going—a faculty like long sight or keen hearing, and independent of intellectual power—requisite to make large profits quickly. In fact, the fortunate man is usually the man who, in consequence of some hidden quality in his nature, deserves fortune.

As to the profitableness of hard-wood timber-growing, Martin Conrad, a wagon-manufacturer, of Chicago, says that of the five principal kinds of timber used in his business, white oak takes eighty years to mature; shell-bark hickory, from thirty to fifty years; white ash, thirty years; tulip-tree, sixty or more years; and red or Norway pine, at least sixty years. An acre of timber artificially grown is worth five times as much as an acre of natural timber. One tree will grow to the rod, or 160 to the acre—say 110 after eighty years. At that time each tree will give 500 feet of lumber, or 55,000 feet to the acre, and that in Chicago would be worth now $14.50 per thousand.

The question whether the rainfall is increasing on the plains has been investigated by Mr. M. W. Harrington, who, for the purpose, has examined two series of observations representing the average conditions at the epochs of 1850 and 1880. They show an apparent increase of rainfall toward the plains.

It is a common mistake, according to an eminent authority on bees, Mr. Frank R. Cheshire, to suppose that an angry bee is certain to sting on alighting upon a human hand. On the contrary, she will always examine the skin very carefully first with her palpi. It may seem that she stings at once, and without care or reflection; but a bee can do a great deal in a very short space of time, in proof of which it may be mentioned that "she can flap her wings more than four hundred times per second, and that each flap involves the extension and contraction, through a nerve impulse, of the muscles employed in the wing-movements."

THE Linnæan Society celebrated its hundredth anniversary May 24th. A eulogy of Linnæus by Prof. Fries, of Upsala, was read by the president, William Carruthers. Sir Joseph Hooker spoke of the merits of Robert Brown, "the greatest botanist of the present century," and said that where others have advanced beyond the goal he reached, it has been by working on the foundations he laid, aided by modern appliances of optics and physics. Prof. Flower delivered an address on Charles Darwin; Prof. W. Thiselton Dyer spoke on George Bentham, "who had stood in the footsteps of Linnæus, and, though the descent was oblique, inherited the mantle of the master." A Linnæan gold medal was instituted, to be presented to a botanist and a zoölogist in alternate years, but on this occasion awarded in duplicate to Sir Richard Owen and Sir Joseph Hooker.

EXPERIMENTS by Dr. Russell, of London, show that city rain contains twice as much impurity as that collected in the suburbs; that is, if the city rain were diluted with a nearly equal bulk of water, we should have the rain of the suburbs. On the basis of Prof. Lodge's experiments in clearing a bell-jar full of smoke by a discharge of electricity, whereby the carbon is deposited, Sir Douglas Galton argues that rain may be induced by disturbing the electrical condition of the air with kites or balloons. If this fails, no remedy for London smoke is left except that of using gas instead of open stoves.

A NATURAL history of panaceas has been suggested, the outline of which might show "how they originate—generally abroad; how some one writes an account of them in English; how every one rushes into print to show that that author is not the only man to go to for treatment; how they are all described as 'the greatest triumph of the century,' and this the more certainly the smaller they are; how they are universally adopted"; and then, after many years, "how they are finally investigated, and are often found to contain nothing."

A DEFORMITY of the hand peculiar to glass-blowers is described by M. Poncet as "glass-blowers' cramp." It consists in a permanent and pronounced flexion of the fingers, particularly of the third and fourth fingers of the hand, which comes on after a short practice in glass-blowing, and increases progressively. The glass-blowers call it *main en crochet*, or *main fermée* (hand in hook, or shuthand). It is supposed to be induced by the close and continuous application of the hand to the tube with which the workman manipulates his "metal."

OBITUARY NOTES.

M. J. C. HOUZEAU, an eminent Belgian astronomer, formerly director of the observatory at Brussels, died early in July. He was one of the editors of "Ciel et Terre," of Brussels, one of the most valued of our foreign scientific exchanges. As a writer, while exact and thoroughly versed—and a leader, too—in science, he employed a popular style, which laymen could read with pleasure, and students with the feeling that they were learning.

M. HENRI DEBRAY, an eminent French chemist, died, July 19th, after a short illness. He was born at Amiens, in 1827, and became the assistant to Sainte-Claire Deville, and eventually the successor to his chair.

PHILIP HENRY GOSSE, F. R. S., an eminent English naturalist, died August 27th, in the seventy-ninth year of his age. He was born in England, but spent much of his youth in Newfoundland and Canada, traveled in the United States, studying our zoölogy and entomology, and sojourned for a considerable time in Alabama. He was author of the "Canadian Naturalist," "The Birds of Jamaica," an "Introduction to Zoölogy," "The Aquarium," "A Manual of Marine Zoölogy," "Life in the Lower, Intermediate, and Higher Forms," a "History of British Sea-Anemones and Corals," "Letters from Alabama on Natural History," "The Romance of Natural History," and several other volumes, with numerous memoirs.

PROF. RUDOLPH J. E. CLAUSIUS, the eminent German physicist, died August 25th, in the sixty-eighth year of his age. He was Professor of Physics in succession at Zurich, Wurzburg, and Bonn, but was most distinguished for his share in the development of the mechanical theory of heat.

PROF. L. J. BUDGE, an eminent German physiologist, for more than thirty years director of the Anatomical Institute at Greifswald, has recently died. He was author of a "Hand-Book of Physiology" and of a "Compendium of Physiology," which is the favorite "cram-book" of the German medical students.

THE death is announced of Dr. Johann Odstreil, an eminent mathematician and physicist of Vienna.

DR. SIGISMUND WROBLEWSKI, Professor of Experimental Physics at the University of Cracow, died in May, from the results of a lamp-explosion in his laboratory. He was born in 1838, studied at St. Petersburg and Strasburg, and was appointed to his professorship in Cracow in 1882. He acquired great fame through his experiments and those which he performed in connection with Prof. Olszewski in the liquefaction and solidification of gases.

THE death is announced, at Rochester, N. Y., of Seth Green, the eminent fish-culturist, at the age of seventy-one years.

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FORTY-THIRD ANNUAL REPORT OF THE

NEW YORK LIFE INSURANCE CO.

Office: Nos. 346 & 348 BROADWAY, NEW YORK.

JANUARY 1, 1888.

Amount of Net Assets, January 1, 1887.....$71,819,693.48

REVENUE ACCOUNT.

Premiums	$17,228,519.87	
Less deferred premiums, January 1, 1887	1,041,666.15	$16,186,853.72
Interest and rents, etc.	4,932,480.50	
Less interest accrued, January 1, 1887	463,497.10	4,765,983.40 — $22,052,787.11

DISBURSEMENT ACCOUNT. $93,872,410.60

Losses by Death, and Endowments matured and discounted (including reversionary additions to same)		$4,561,866.88
Dividends (including mortuary dividends), annuities, and purchased insurances		5,178,843.96
Total paid policy-holders	$9,740,710.79	
Taxes and re-insurances		264,495.60
Commissions (including advanced and commuted commissions), brokerages, agency expenses, physicians' fees, etc.		2,361,024.06
Office and law expenses, salaries, advertising, printing, etc		369,360.96 — $15,060,088.45

ASSETS. $79,912,317.17

Cash on deposit, on hand, and in transit		$3,038,499.60
United States Bonds and other bonds and stocks (market value, $50,255,894.83)		49,088,386.14
Real Estate		6,987,092.59
Bonds and Mortgages, first lien on real estate (buildings thereon insured for $14,000,000 and the policies assigned to the Company as additional collateral security)		15,969,472.78
Temporary Loans (market value of securities held as collateral, $2,404,853)		1,867,500.00
* Loans on existing policies (the Reserve on these policies, included in Liabilities, amounts to over $2,000,000)		888,790.44
* Quarterly and semi-annual premiums on existing policies, due subsequent to January 1, 1888		1,174,340.36
* Premiums on existing policies in course of transmission and collection. (The Reserve on these policies, included in Liabilities, is estimated at $1,000,000)		929,158.08
Agents' balances		170,792.59
Accrued Interest on investments, January 1, 1888		498,477.59 — $79,912,317.17
Market value of securities over cost value on Company's books		3,157,328.68

* A detailed schedule of these items will accompany the usual annual report filed with the Insurance Department of the State of New York.

TOTAL ASSETS, January 1, 1888.....$83,079,845.85

APPROPRIATED AS FOLLOWS:

Approved losses in course of payment		$397,078.28
Reported losses awaiting proof, etc		292,214.54
Matured endowments, due and unpaid (claims not presented)		27,582.20
Annuities due and unpaid (claims not presented)		16,042.96
Reserved for re-insurance on existing policies; participating insurances at 4 per cent Carlisle net premium; non-participating at 5 per cent Carlisle net premium	$66,897,643.00	
Additional amount of Reserve (transferred from Surplus account) required on account of new State Standard of valuation (Actuaries' 4 per cent), taking effect December 31, 1887	1,502,096.00 —	70,399,740.00
Reserved for contingent liabilities to Tontine Dividend Fund, January 1, 1887, over and above a 4 per cent Reserve on existing policies of that class	4,176,425.25	
Addition to the Fund during 1887	1,785,602.54	
DEDUCT—	$5,962,027.79	
Returned to Tontine policy holders during the year on matured Tontines	646,306.96	
Balance of Tontine Fund, January 1, 1888		5,315,720.83
Reserved for premiums paid in advance		52,886.78
		$76,428,265.74
Divisible Surplus (Company's new Standard)		6,651,580.11
		$83,079,845.85

Surplus by the present New York State Standard, i. e., 4 per cent Actuaries' (including the Tontine Fund).....$11,846,793.09

From the undivided surplus, as above, the Board of Trustees has declared a Reversionary dividend to participating policies in proportion to their contribution to surplus, available on settlement of next annual premium.

Number of Policies issued during the year, 28,522. Risks assumed, $106,749,295.

Total number of Policies in force December 31, 1887, 113,323. Amount at risk, $358,935,536.

TRUSTEES:

WM. H. APPLETON,	HENRY BOWERS,	ELIAS S. HIGGINS,	GEORGE H. POTTS,	W. F. BUCKLEY,
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